

Section 11 Waterfront Geographic Zone (T-096 to T-115)

11.1 Overall Location

For reporting purposes for this AIS, the City Center Section 4 of the HHCTCP has been divided into 11 zones based on geographical and cultural boundaries. The Waterfront Geographic Zone runs along Nimitz Highway from Nu‘uanu Stream at the north end to Richards Street at the south end. The northern boundary represents the southern boundary of the former Kawa Fishpond/historic shoreline and Nu‘uanu Stream (see Volume II Figure 12, Volume II Figure 26, and Volume II Figure 27). The Waterfront Zone corridor is located entirely within Honolulu Ahupua‘a, although the present-day northern and southern ends of the zone were offshore in Traditional Hawaiian times.

The Waterfront Zone includes twenty-two AIS Test Excavations numbered T-096 through T-115, including T-104A and T-111A. Test excavations were generally numbered from north to south. The test excavations within the Waterfront Zone were located within TMKs [1] 1-7-002:026 (Chinatown Station; land owned by 902 Partners, LLC.), [1] 1-7-002, [1] 2-1-001, -002, -013, and -014 (Nimitz Highway; owned by the State of Hawai‘i), and [1] 2-1-014:003 (Downtown Station; land owned by Pacific Guardian Center).

11.2 Geography, Geology, and Land Forms

The Waterfront Zone is situated along the low-lying coastal flats immediately inland of Honolulu Harbor, generally less than 0.5 km from the shoreline. Elevations within the Waterfront Zone range from approximately 1.9 to 2.4 m amsl, and the average annual rainfall is approximately 691 to 762 mm (27 to 30 inches) (Giambelluca et al. 2011). The present-day topography of the Waterfront Zone is generally flat. As the Waterfront Zone traverses a predominantly urban landscape, vegetation in the immediate vicinity is minimal and consists primarily of introduced (non-indigenous) landscaping trees, shrubs, and ground cover. Nu‘uanu Stream empties into Honolulu Harbor at the north end of the Waterfront Zone.

According to the U.S. Department of Agriculture Soil Survey Geographic (SSURGO) Database (U.S. Department of Agriculture, National Resources Conservation Service 2001) and soil survey data gathered by Foote et al. (1972), soils within the Waterfront Zone consist predominantly of Fill Land (FL), with small areas of ‘Ewa Silty Clay Loam (EmA) at the northeast and southeast ends of the Zone (Figure 220). Fill Land soils are described as:

...areas filled with material dredged from the ocean or hauled from nearby areas, garbage, and general material from other sources.... This land type is used for urban development including airports, housing areas, and industrial facilities. (Foote et al. 1972:31)

‘Ewa Silty Clay Loam soils are described as follows:

...well-drained soils in basins and on alluvial fans...[that] developed in alluvium derived from basic igneous rock.... These soils are used for sugarcane, truck crops, and pasture. The natural vegetation consists of fingergrass, kiawe, koa haole, klu, and uhaloa. (Foote et al. 1972:29)

11.3 Modern Land Use and Built Environment

The Waterfront Zone traverses an urban environment centered around Honolulu Harbor. Today, the harbor area still functions as the state's major port facility. The centerline of the project alignment within the Waterfront Zone lies within Nimitz Highway. Honolulu Harbor lies immediately adjacent to the highway throughout much of its length, with many wharves and industrial warehouses fronting the harbor. Parcels bordering Nimitz Highway *mauka* contain largely commercial and residential structures with associated parking lots. A massive utility corridor is also present throughout the Waterfront Zone containing electrical, gas, water, sewer, and storm lines. The number and distribution of these existing utilities indicates that this portion of the transit corridor has been heavily disturbed in the past.

11.4 GPR Sediment Summary

Test excavations in the Downtown Geographic Zone (Zone 6) revealed that the area was predominantly Fill Lands (FL) as predicted by the U.S.G.S. Soil survey map of the zone (Figure 220). Naturally deposited sediments encountered in this zone during test excavations were generally too deep for the GPR to clearly read. The average depth of clean signal return for this area was approximately one m. The only naturally deposited sediment observed in Zone 6 within the range of clean signal return was sandy loam located in T-104A. Representative signal texture profiles for Zone 6 are shown in Figure 221. Signal texture profiles were only collected if the signal return was clear and the stratum was at least 0.25 m thick.

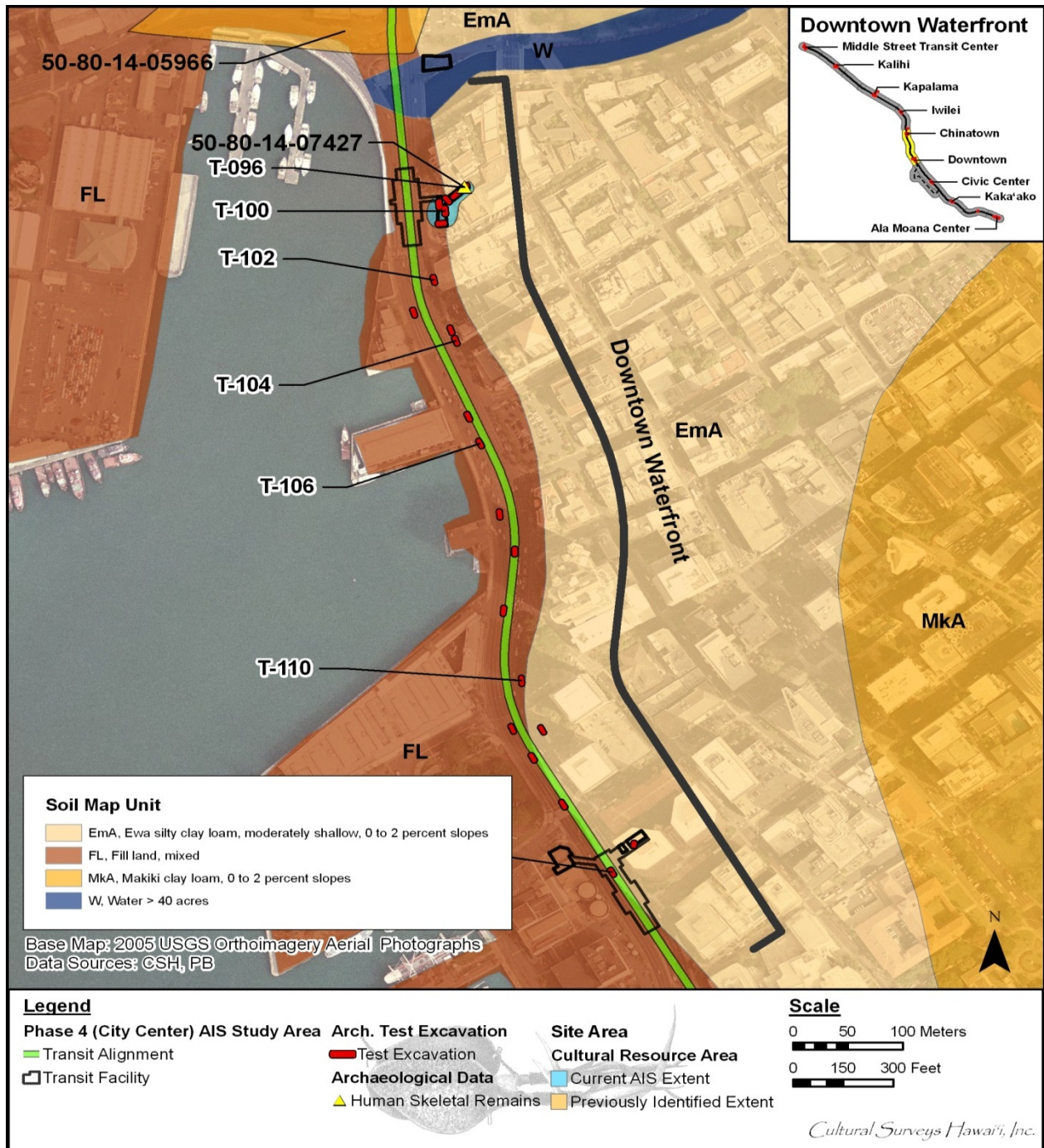
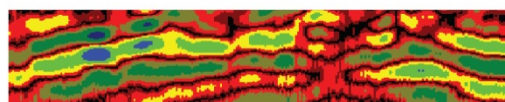
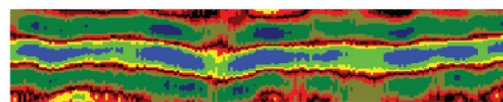
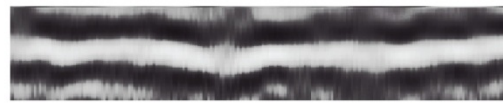


Figure 220. Aerial photograph (source: U.S. Geological Survey Orthoimagery 2005) with overlay of the Soil Survey of Hawai'i (Foote et al. 1972) showing sediment types within and in the vicinity of the Waterfront Zone

Examples of GPR Signal Textures Representing Zone 6 Sediments



Silty Clay Loam (T-098)



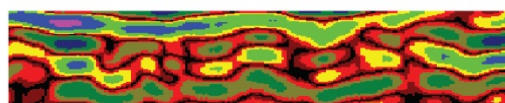
Silty Loam (T-103)



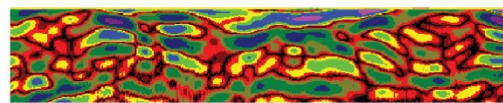
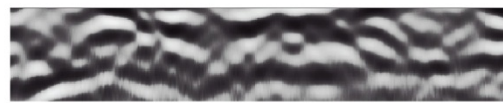
Very Gravelly Sandy Loam (T-100)



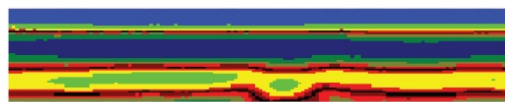
Crushed Coral Sand (T-099)



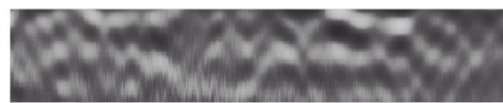
Clay (T-101)



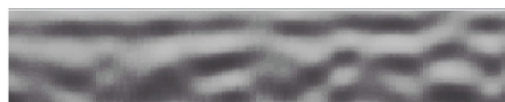
Loamy Sand (T-112)



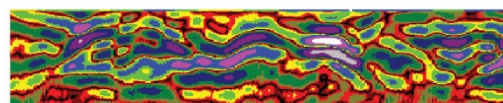
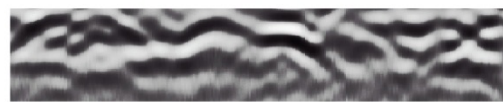
Asphalt (T-102)



Clay Loam (T-113)



Basalt Gravel Base Course (T-103)



Sandy Loam (T-100)
Naturally Deposited

Figure 221. Examples of GPR signal textures representing Zone 6 sediments

Test Excavation 96

T-096 measured 0.65 m by 6.74 m and was oriented northeast to southwest and was located 64 m northeast of Kekaulike Street and North Nimitz Highway intersection, within a parking lot behind Fong's Meat Market. The GPR measured 2.5 m by 21 m with 25 cm spacing between Y-transects and 1 m spacing between X-transects. According to PB CADD, there were no utilities located within close proximity of the excavation. A concrete slab was encountered 27 mbs in the southwestern wall, an old brick building foundation was encountered 0.27 mbs along the western wall, and an isolated human skeletal remain fragment was encountered 0.7 mbs in the southwestern end of the excavation.

A review of amplitude slice maps indicated no linear features which might have indicated the presence of utilities although a concrete slab and a brick building foundation were encountered during excavation. Reflectivity was relatively uniform throughout the grid and decreased with depth. A transition from higher reflectivity to lower reflectivity was observed at approximately 0.75 mbs (Figure 222).

GPR depth profiles for T-096 identified horizontal banding, commonly associated with stratigraphic layering, throughout the survey area (Figure 223). This banding corresponded to variations of density and chemical composition within fill deposits. The profile also indicated a change in reflectivity which occurred around 0.2 mbs. The profile did show an anomaly on the southeast end of the excavation which could correspond to a concrete slab that was encountered during excavation. The maximum depth of clean signal return was approximately 1.0 mbs.

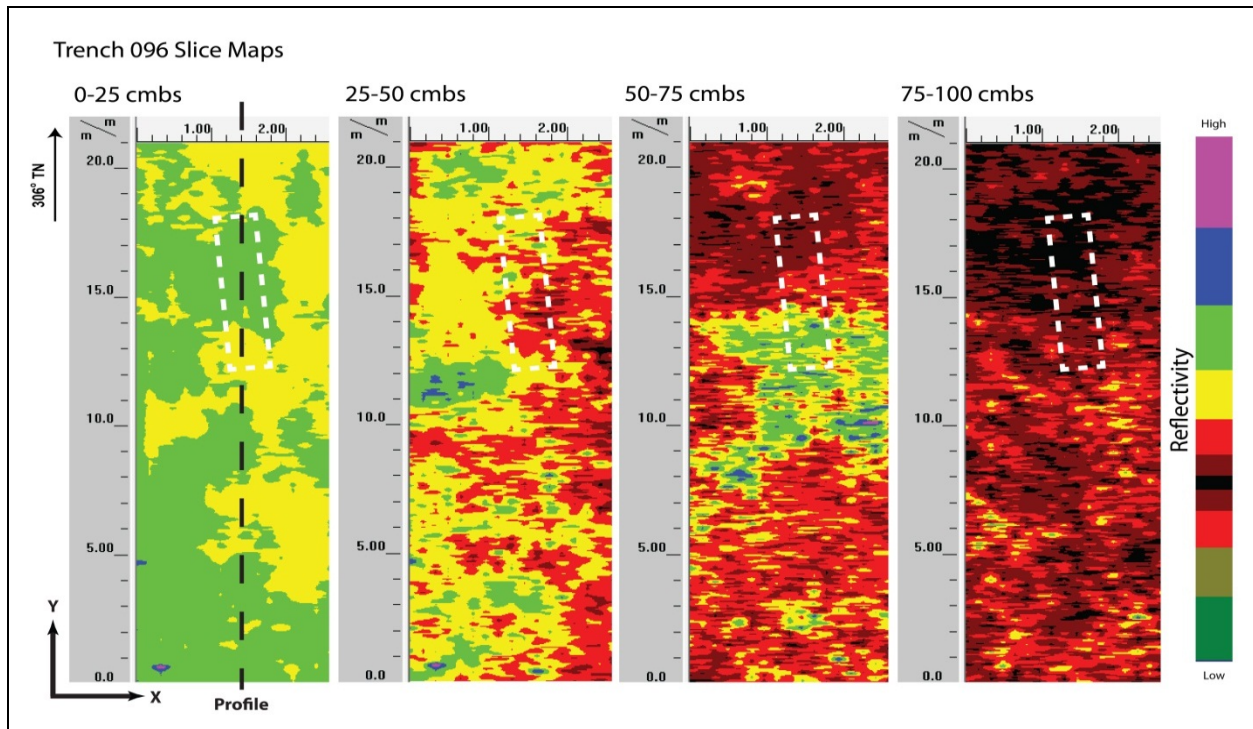


Figure 222. Slice maps of T-096 at 25 cm depth intervals

A visual comparison of the excavated profile and the GPR signal profile showed a strong correlation in stratigraphic transitions (Figure 223). Strata Ia to Ig were clearly observed and occurred at the ground-truthed depths. A void was observed on the profile and corresponded to Stratum Ig which was gravelly silty loam fill. Several strata, such as Ic and Ie, were less than 5 cm in thickness and were not able to be distinguished from the former stratum due to the fact. A concrete slab and an old brick building foundation were found 0.27 mbs. An anomaly was observed in the profile that corresponded to these items. A human skeletal remain fragment was found 0.7 mbs within a gravelly sandy loam fill layer and was not able to be observed in the profile or slice maps. All other sediment transitions were below the maximum clean signal return depth. No other discrete objects were observed in the GPR results or subsequent excavation.

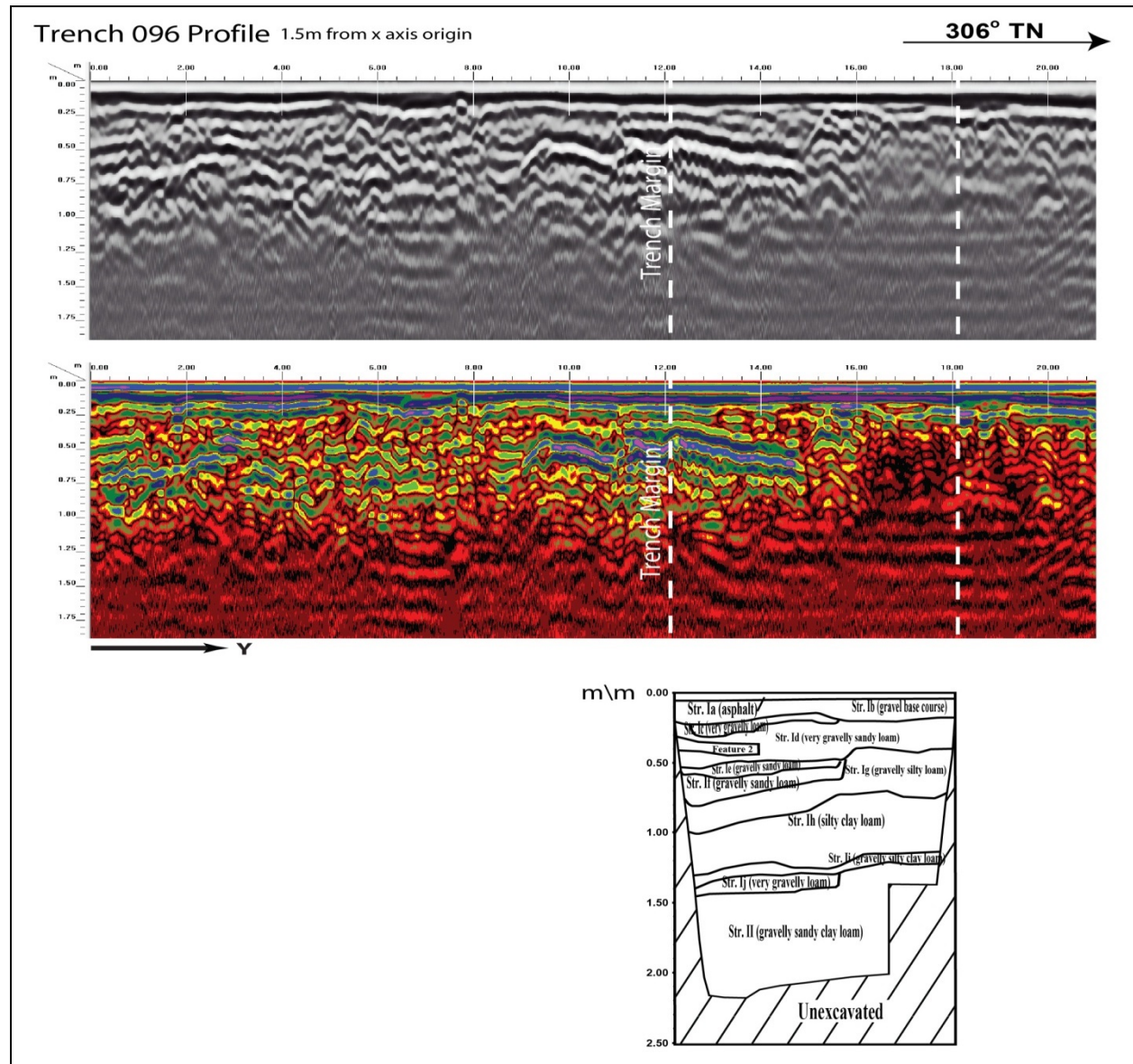


Figure 223. Visual comparison of excavated profile and GPR signal profile of T-096

Test Excavation 97

T-097 measured 1 m by 6 m and was oriented northeast to southwest and was located 50 m northeast of North Nimitz Highway and Kekaulike Street intersection, within the parking lot behind Fong's Meat Market. The GPR grid measured 2.5 m by 21 m with 25 cm spacing between Y-transects and 1 m spacing between X-transects. According to PB CADD, there were no utilities located within close proximity of the excavation. An abandoned metal utility pipe was encountered 40 mbs in the center of the excavation, A concrete jacket was encountered 0.35 mbs along the northwestern wall, an abandoned utility was encountered 0.5 mbs along the southeastern wall, a concrete jacket was encountered 20 mbs in the southwestern end, and an abandoned utility was encountered 1.22 mbs in the northeast end of the excavation.

A review of amplitude slice maps indicated no linear features although several utilities were encountered during excavation. Reflectivity was relatively uniform throughout the grid and decreased with depth. A transition from higher reflectivity to lower reflectivity was observed at approximately 0.75 mbs (Figure 224).

GPR depth profiles for T-097 identified horizontal banding, commonly associated with stratigraphic layering, throughout the survey area (Figure 225). This banding corresponded to variations of density and chemical composition within fill deposits. The profile also indicated a change in reflectivity which occurred around 0.15 mbs. An anomaly was observed in the profile and it could correspond with one or two of the abandoned utility pipes encountered during excavation. The maximum depth of clean signal return was approximately 1.0 mbs.

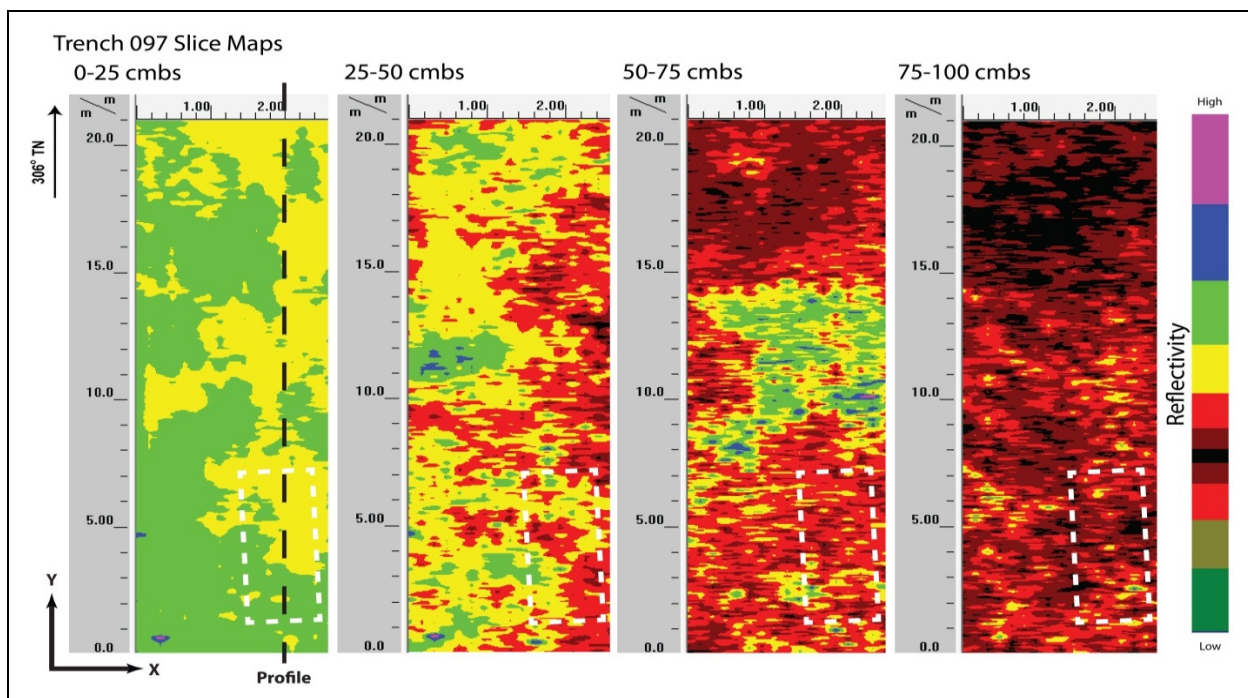


Figure 224. Slice maps of T-097 at 25 cm depth intervals

A visual comparison of the excavated profile and the GPR signal profile showed a weak correlation in stratigraphic transitions (Figure 225). Strata included: asphalt, gravel, crushed coral, burnt trash, very gravelly sandy loam fill, silty clay loam fill, and then natural sandy loam. These transitions were not clearly depicted in the GPR profile at the depths that they occurred. Two concrete jackets were found at 0.2 mbs and 0.35 mbs. Neither of these jackets were observed in the profile. This may be due to the fact that the concrete was not reinforced with steel (rebar) or because it was of similar density as the stratum surrounding it. Three abandoned utilities were found at 0.4, 0.5, and 1.22 mbs. The abandoned pipes found at 0.4 and 0.5 mbs could correspond to an anomaly observed in the GPR profile. The abandoned utility found at 1.22 mbs was below the maximum depth of clean signal return. No other sediment transitions or discrete objects were observed in the GPR results or subsequent excavation.

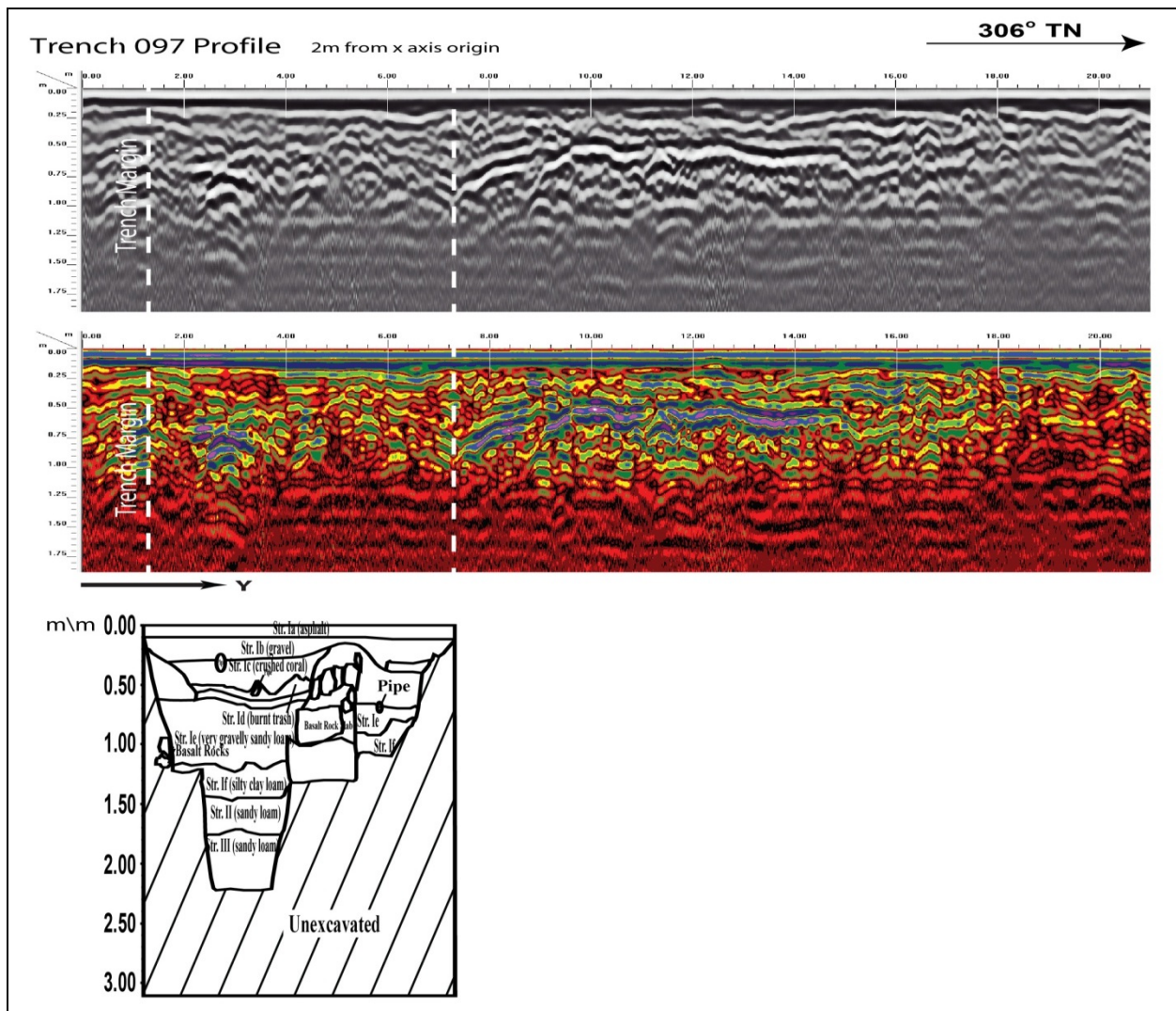


Figure 225. Visual comparison of excavated profile and GPR signal profile of T-097

Test Excavation 98

T-098 measured 0.6 m by 6 m and was oriented northwest to southeast and was located 18 m east of Nimitz Highway, within a private parking lot. The GPR grid measured 3 m 10 m with 25 cm spacing between Y-transects and 1 m spacing between X-transects. According to PB CADD, there were no utilities that were within close proximity to the excavation location. A concrete slab was encountered approximately 0.5 mbs on the northwestern end and a PVC and copper utility pipe were encountered 0.4 mbs in the southeast of the excavation.

A review of amplitude slice maps indicated linear features, one which might correspond to the concrete slab and the other to the utility pipes encountered during excavation. Reflectivity was relatively uniform throughout the grid and decreased with depth. A transition from higher reflectivity to lower reflectivity was observed at approximately 0.5 mbs (Figure 226).

GPR depth profiles for T-098 identified horizontal banding, commonly associated with stratigraphic layering, throughout the survey area (Figure 227). This banding corresponded to variations of density and chemical composition within fill deposits. The profile also indicated a change in reflectivity which occurred around 0.15 mbs. Anomalies were observed in the profile and correspond to the utility pipes and the concrete slab that were encountered during excavation. The maximum depth of clean signal return was approximately 1.0 mbs.

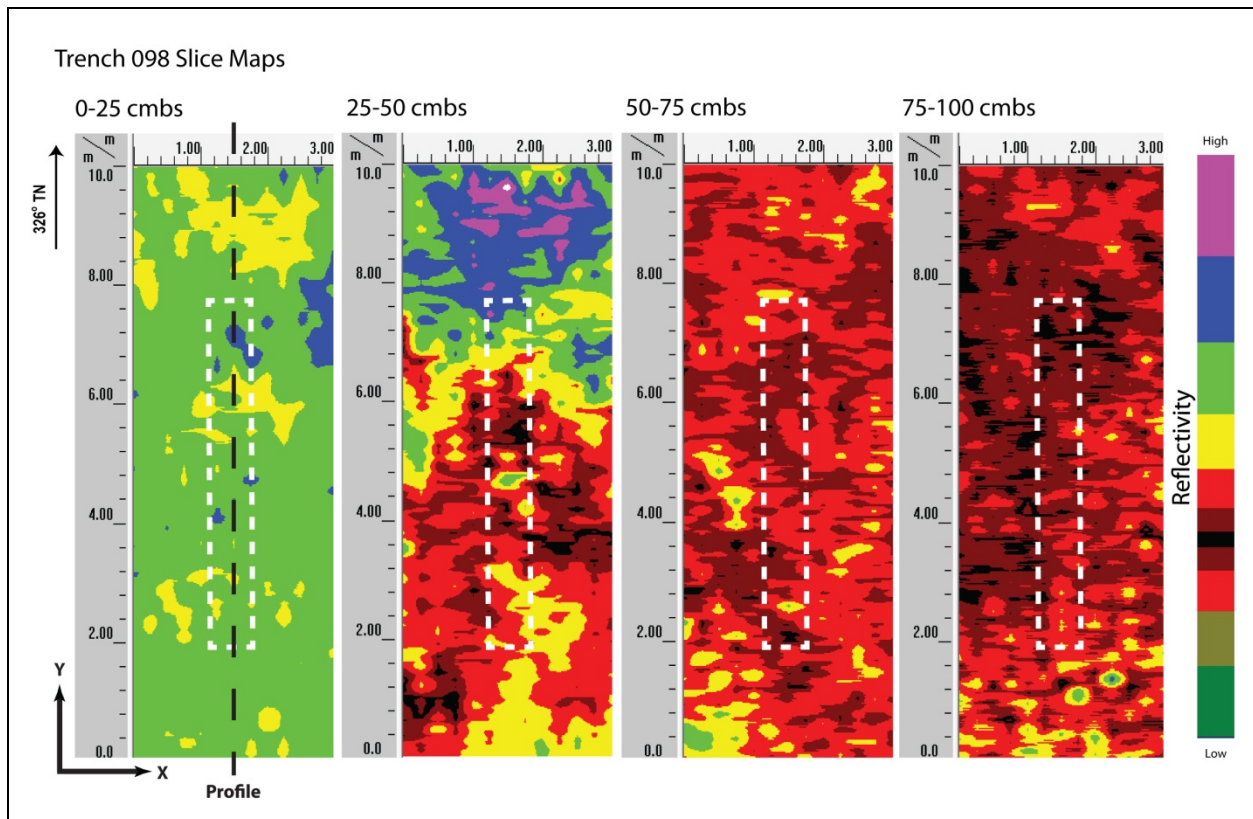


Figure 226. Slice maps of T-098 at 25 cm depth intervals

A visual comparison of the excavated profile and the GPR signal profile showed a strong correlation in stratigraphic transitions (Figure 227). Strata Ia to If were clearly observed and occurred at the ground-truthed depths. A void was observed in the profile truncating strata Ie through If. This void corresponded to the concrete slab that was found 0.5 mbs. A copper and PVC pipe were found 0.4 mbs. These pipes were observed in both the profile and slice maps. No other discrete objects were observed in the GPR results or subsequent excavation.

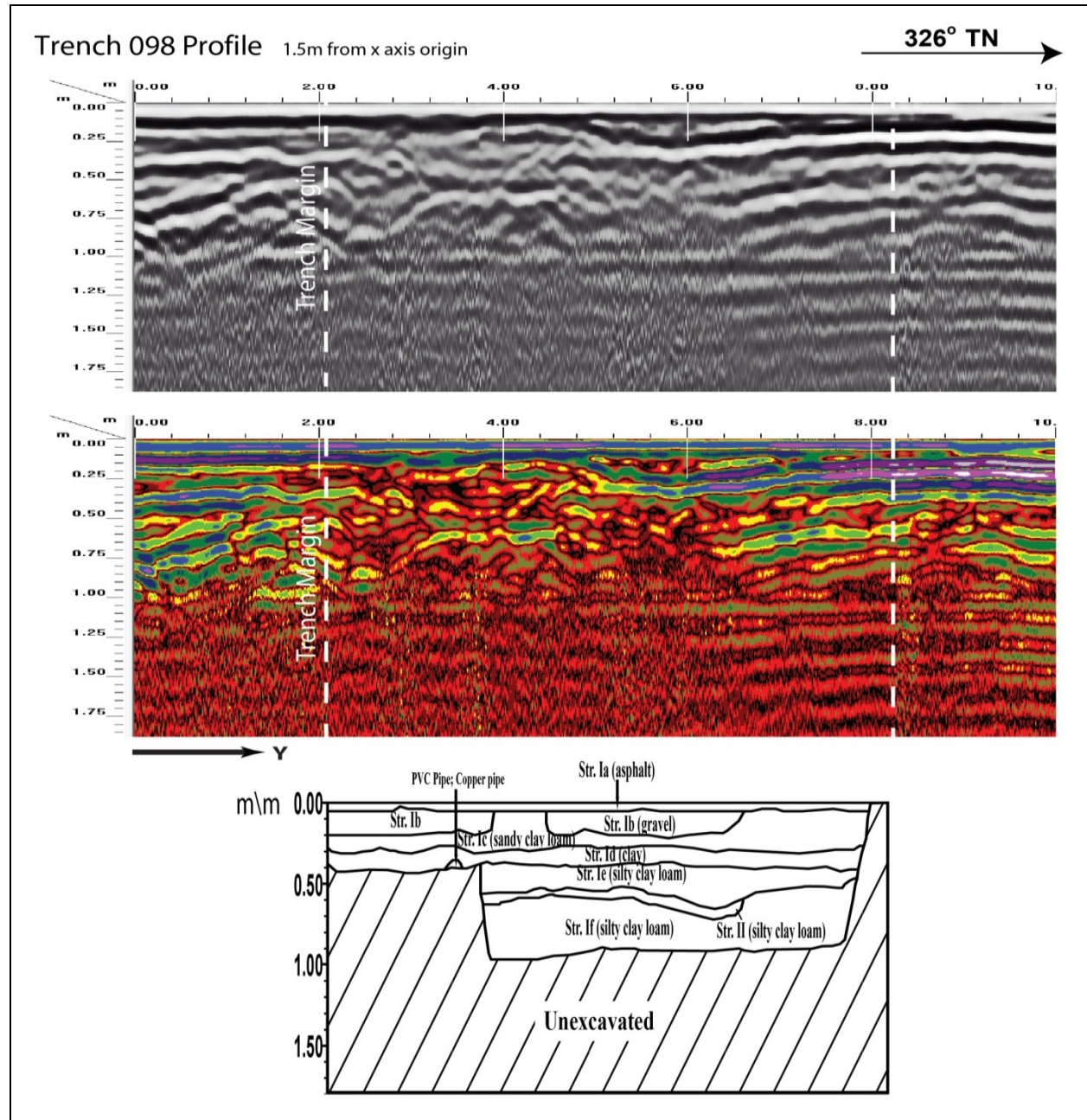


Figure 227. Visual comparison of excavated profile and GPR signal profile of T-098

Test Excavation 99

T-099 measured 1 m by 6 m and was oriented north to south and was located 11 m east of Nimitz Highway, within a private parking lot, 40 m northeast of Nimitz Highway and Kekaulike Street intersection. The GPR grid measured 3 m by 10 m with 25 cm spacing between Y-transects and 1 m spacing between X-transects. Utilities located near the excavation include an electrical line 8 m west. A concrete slab was encountered 15–42 mbs spanning the entire length of the excavation, a PVC utility pipe was encountered 29–31 mbs in the center of the excavation, and two metal utilities approximately 0.42 mbs oriented across the excavation on the southern end.

A review of amplitude slice maps indicated a linear feature which might correspond to the concrete slab encountered during excavation. Reflectivity was relatively uniform throughout the grid and decreased with depth. A transition from higher reflectivity to lower reflectivity was observed at approximately 0.5 mbs (Figure 228).

GPR depth profiles for T-099 identified horizontal banding, commonly associated with stratigraphic layering, throughout the survey area (Figure 229). This banding corresponded to variations of density and chemical composition within fill deposits. The profile also indicated a change in reflectivity which occurred around 0.15 mbs. An anomaly was observed in the profile and could correspond to the utility pipes encountered during excavation. The maximum depth of clean signal return was approximately 1.0 mbs.

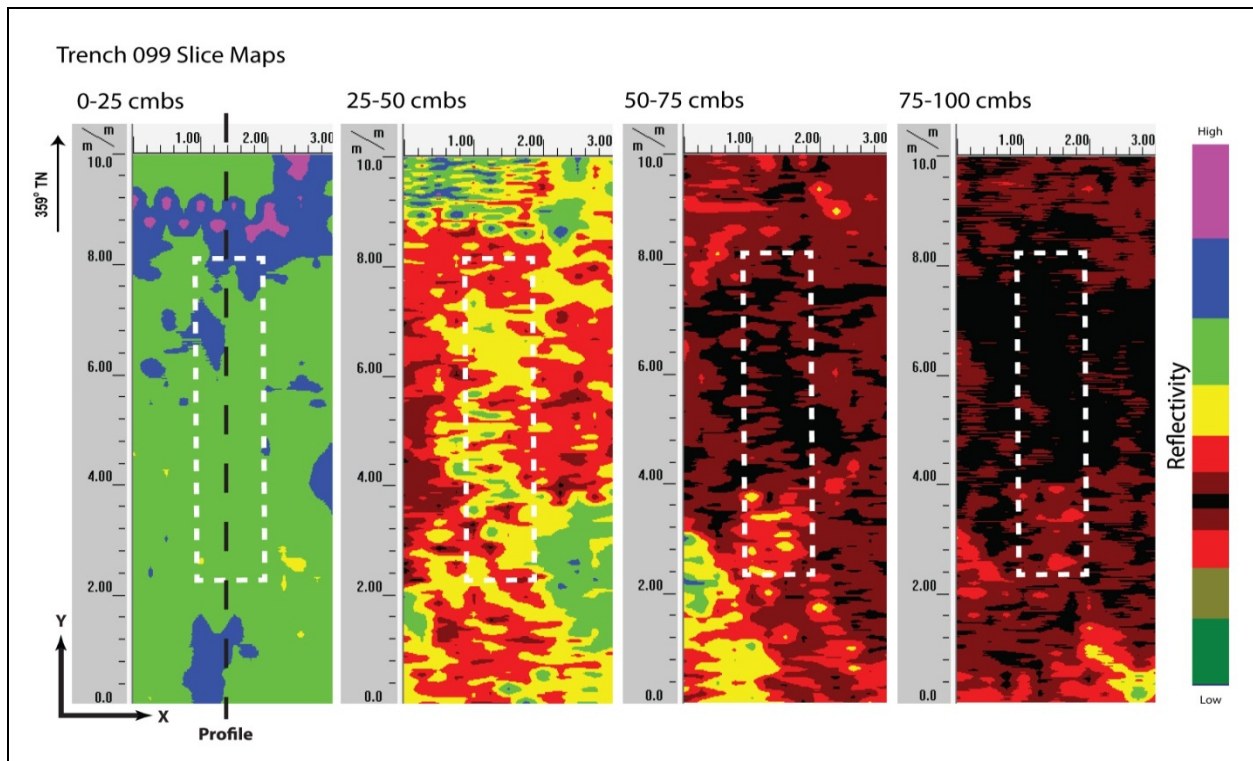


Figure 228. Slice maps of T-099 at 25 cm depth intervals

A visual comparison of the excavated profile and the GPR signal profile showed a moderate correlation in stratigraphic transitions (Figure 229). Strata Ia to Ic and If were all clearly observed and occurred near the ground-truthed depths. Avoid was observed around 0.5 mbs and corresponded to the basalt boulders encountered in Stratum If. Three utility pipes and a concrete slab were found at 0.29, 0.42 and 0.15 mbs, respectively. The pipes found at 0.42 mbs seem to correspond to an anomaly observed in the profile maps. The concrete slab and the other pipe did not show up in the profile or slice maps. No other discrete objects were observed in the GPR results or subsequent excavation.

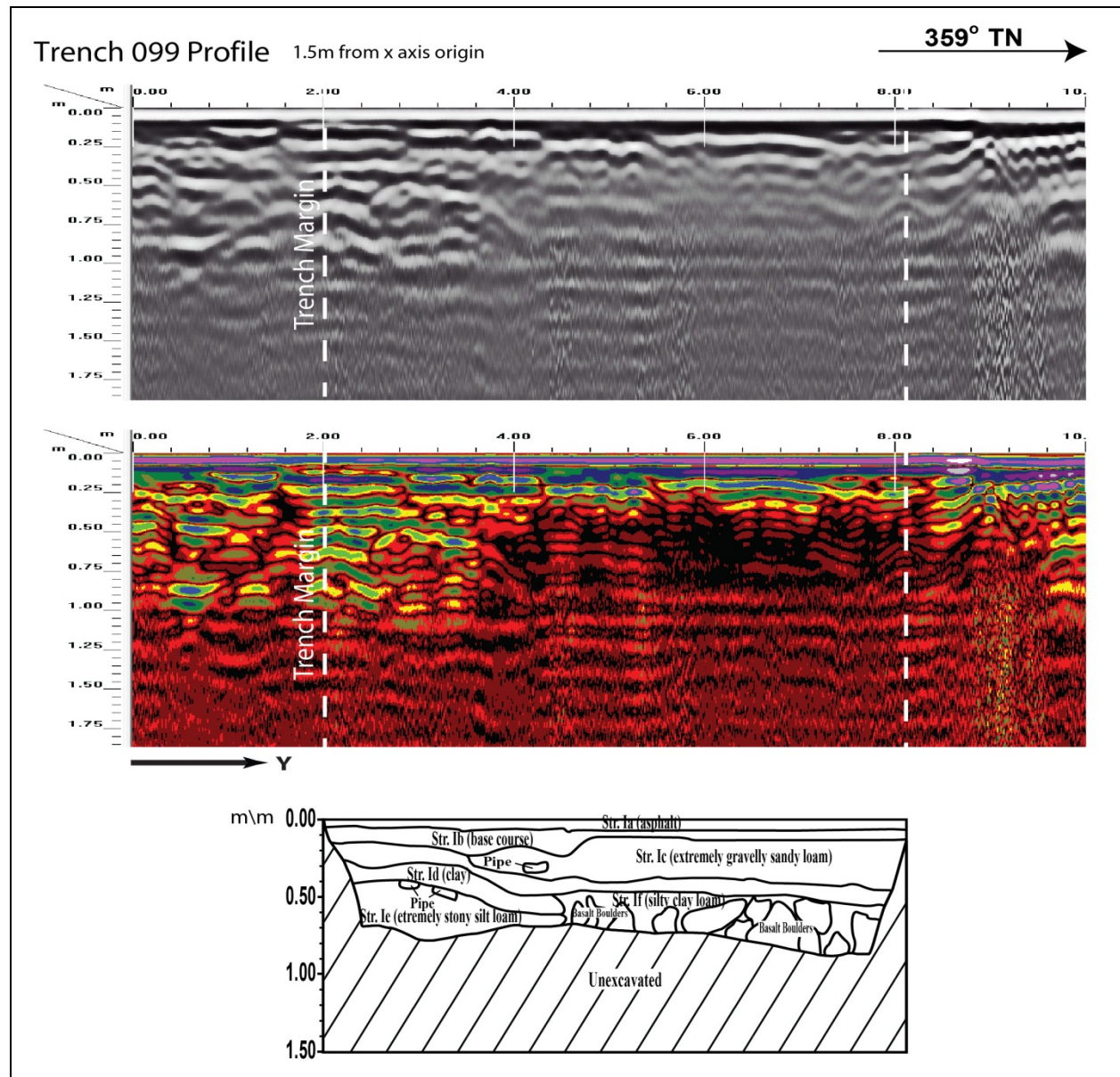


Figure 229. Visual comparison of excavated profile and GPR signal profile of T-099

Test Excavation 100

T-100 measured 1 m by 6 m and was oriented north to south and was located 16 m east of Nimitz Highway, within a private parking lot, 32 m northeast of Nimitz Highway and Kekaulike Street intersection. The GPR grid measured 3 m by 10 m with 25 cm spacing between Y-transects and 1 m spacing between X-transects. No utilities were within close proximity to the excavation location. A concrete slab was encountered 0.19 mbs and spanned the entire excavation length and a metal utility pipe was encountered 0.4 mbs and stretched across the center of the excavation.

A review of amplitude slice maps indicated no linear features although a utility and a concrete slab were encountered during excavation. Reflectivity was relatively uniform throughout the grid and decreased with depth. A transition from higher reflectivity to lower reflectivity was observed at approximately 0.25 mbs and increases again around 0.75 mbs, possibly due to large coral boulders encountered 0.7–1.3 mbs (Figure 230).

GPR depth profiles for T-100 identified horizontal banding, commonly associated with stratigraphic layering, throughout the survey area (Figure 231). This banding corresponded to variations of density and chemical composition within fill deposits. The profile also indicated a change in reflectivity which occurred around 0.05 mbs and again around 0.3 mbs. A large and small anomaly were observed in the profile. The large anomaly did not correspond to the utility or concrete slab that was encountered but the small anomaly corresponded to the pipe that was encountered during excavation. The maximum depth of clean signal return was approximately 1.0 mbs.

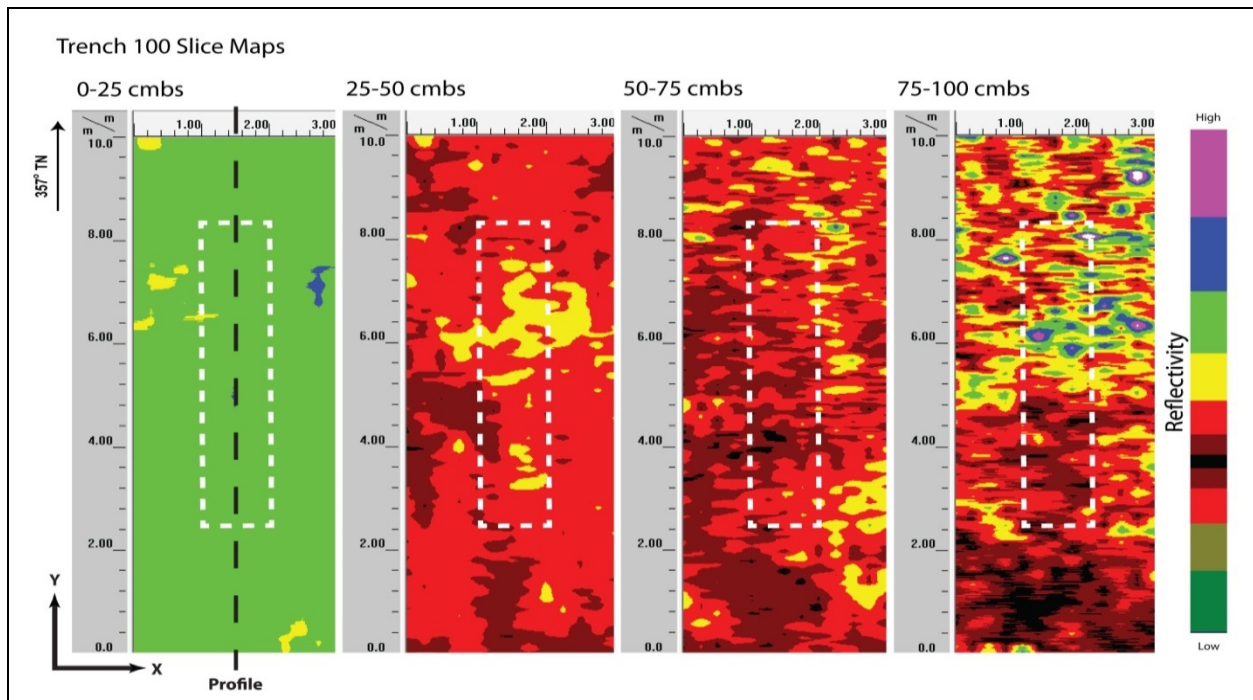


Figure 230. Slice maps of T-100 at 25 cm depth intervals

A visual comparison of the excavated profile and the GPR signal profile showed a moderate correlation in stratigraphic transitions (Figure 231). Strata Ia to Ie and II were all clearly observed and occurred near the ground-truthed depths. A metal utility pipe was found 0.4 mbs. The pipe corresponded with a small anomaly at this location in the profile map. A concrete slab was found 0.19 mbs. This slab was not observed in the profile possibly due to the fact that it did not contain reinforced steel (rebar) or because it was a very thin layer. All sediment transitions below Stratum II cannot be seen in the profile because they were below the maximum clean signal return depth. No other discrete objects or other stratigraphic transitions were observed in the GPR results or subsequent excavation.

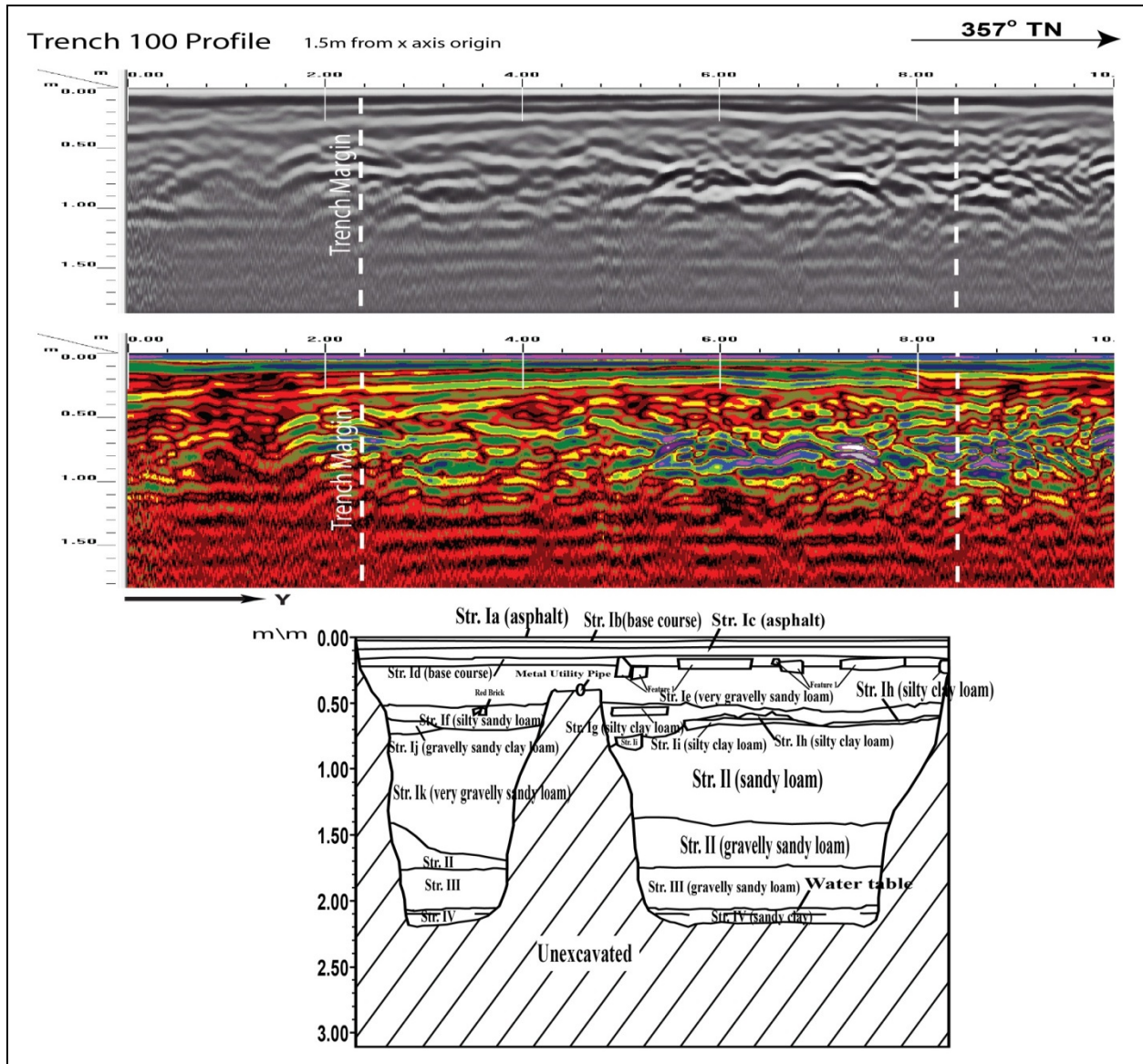


Figure 231. Visual comparison of excavated profile and GPR signal profile of T-100

Test Excavation 101

T-101 measured 1 m by 6 m and was oriented east to west and was located 9.5 m east of North Nimitz Highway, within a private parking lot, 20 m northeast of Nimitz Highway and Keakaulike Street intersection. The GPR grid measured 3 m by 10 m with 25 cm spacing between Y-transects and 1 m spacing between X-transects. Utilities locate near the excavation include an electrical line 8.5 m west. A concrete slab was encountered 0.15 mbs in the northern side of excavation.

A review of amplitude slice maps indicated no linear features although a concrete slab was encountered during excavation. Reflectivity was relatively uniform throughout the grid and decreased with depth. A transition from higher reflectivity to lower reflectivity was observed at approximately 0.5 mbs (Figure 232).

GPR depth profiles for T-101 identified horizontal banding, commonly associated with stratigraphic layering, throughout the survey area (Figure 233). This banding corresponded to variations of density and chemical composition within fill deposits. The profile also indicated a change in reflectivity which occurred around 0.25 mbs. No utilities were observed in the profile although a concrete slab was encountered during excavation. The maximum depth of clean signal return was approximately 1.0 mbs.

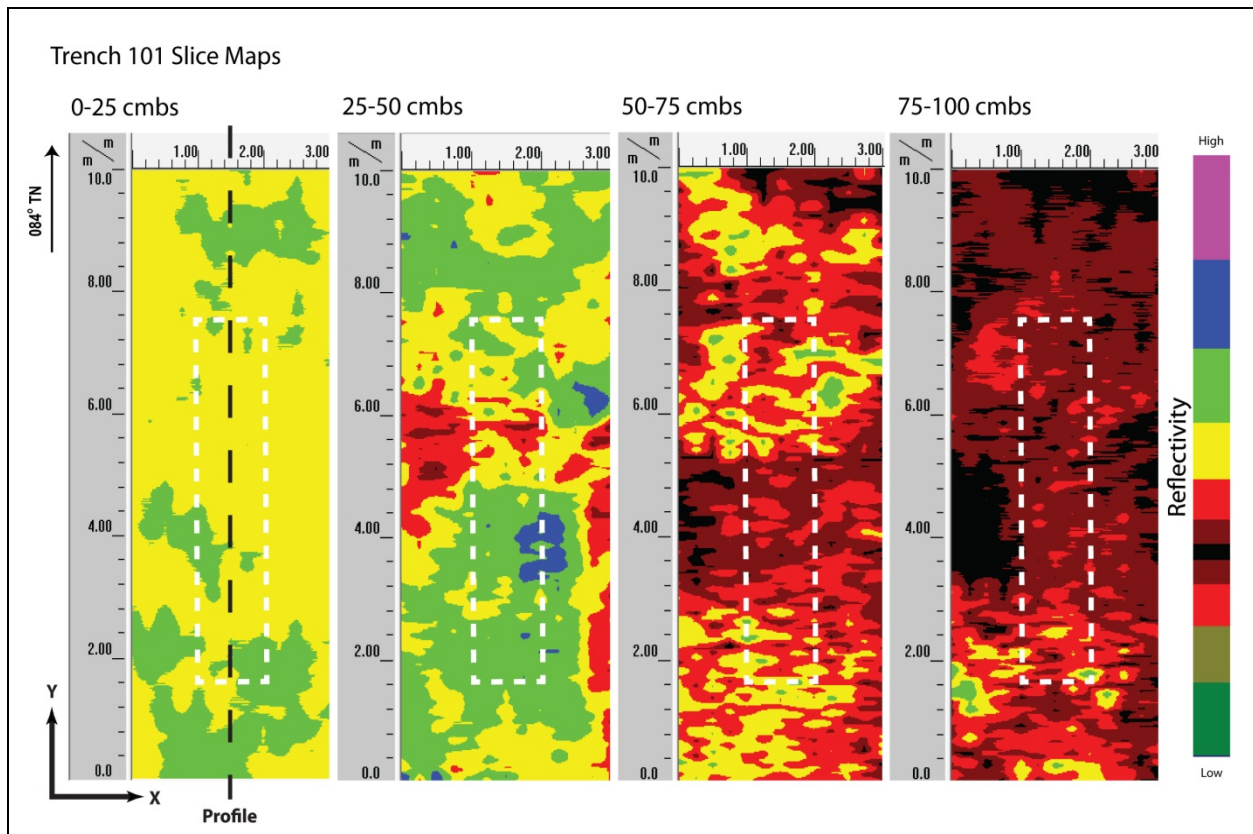


Figure 232. Slice maps of T-101 at 25 cm depth intervals

A visual comparison of the excavated profile and the GPR signal profile showed a moderate correlation in stratigraphic transitions (Figure 233). Strata Ia to Id and feature 2 were all clearly observed and occurred at the ground-truthed depths. A concrete slab was found 0.15 mbs. This concrete slab did not show up on the profile or slice maps. This may be due to the fact that it did not contain reinforced steel (rebar) or it may have had a similar density to the surrounding stratum. No other discrete objects were observed in the GPR results or subsequent excavation.

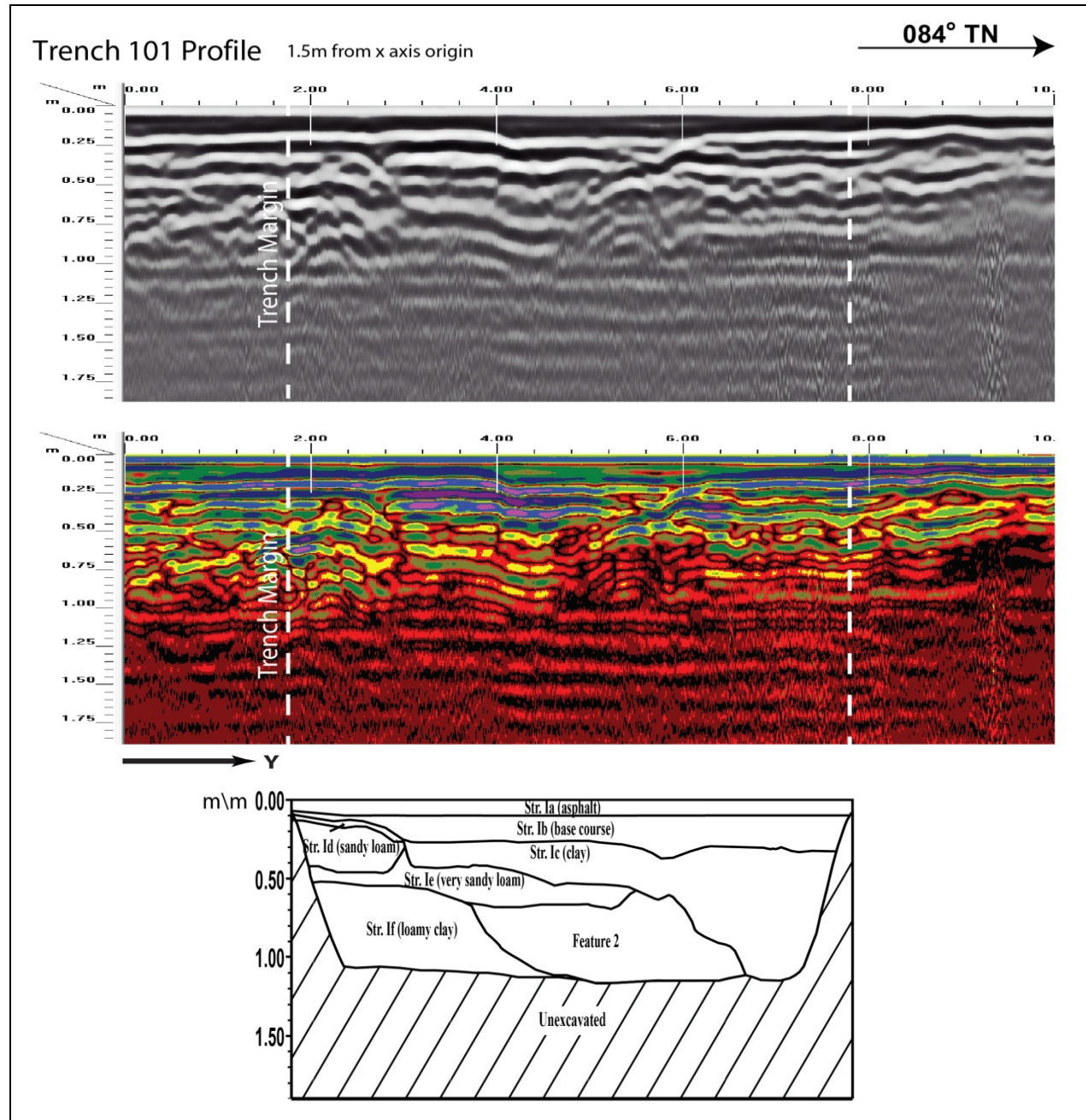


Figure 233. Visual comparison of excavated profile and GPR signal profile of T-101

Test Excavation 102

T-102 measured 0.6 m by 6 m and was oriented north to south and was located within the bike lane on North Nimitz Highway, 30 m south of Nimitz Highway and Kekaulike Street intersection. The GPR grid measured 3 m by 10 m with 25 cm spacing between Y-transects and 1 m spacing between X-transects. Utilities located near the excavation include electrical cable .8 m west, water line 1.5 m west, gas line 3.3 m west, and sewer line 4.7 m west. No utilities transected the GPR grid or excavation location.

A review of amplitude slice maps indicated no linear features which might have indicated the presence of utilities. Reflectivity was relatively uniform throughout the grid and decreased with depth. A transition from higher reflectivity to lower reflectivity was observed at approximately 0.75 mbs (Figure 234).

GPR depth profiles for T-102 identified horizontal banding, commonly associated with stratigraphic layering, throughout the survey area (Figure 235). This banding corresponded to variations of density and chemical composition within fill deposits. The profile also indicated a change in reflectivity which occurred around 0.15 mbs and again around 0.4 mbs. No utilities were observed in the profile. The maximum depth of clean signal return was approximately 1.0 mbs.

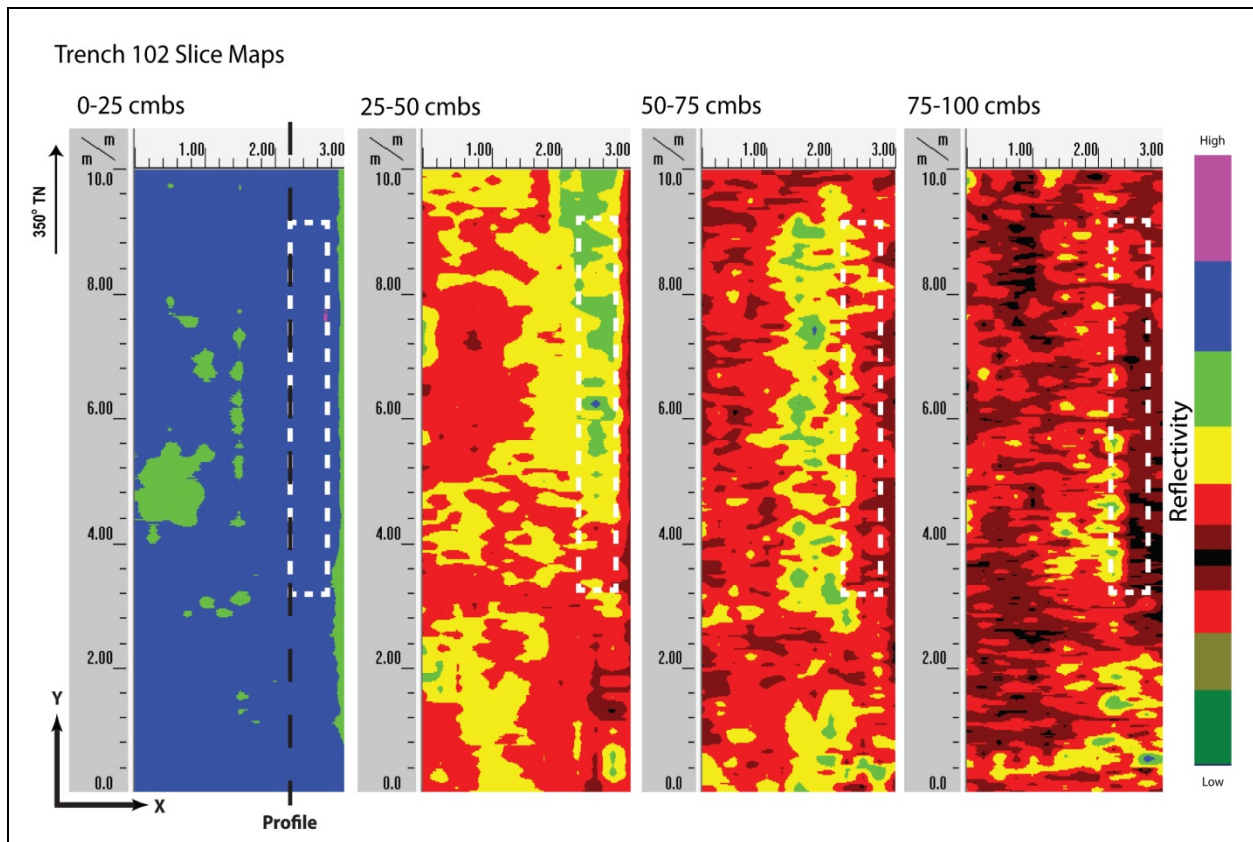


Figure 234. Slice maps of T-102 at 25 cm depth intervals

A visual comparison of the excavated profile and the GPR signal profile showed a strong correlation in stratigraphic transitions (Figure 235). Strata Ia to Ic were clearly observed and occurred at the ground-truthed depths. Textural changes in the form of multiple small hyperbolas were apparent in Stratum Ic which was crushed coralline sand fill. No discrete objects or other stratigraphic transitions were observed in the GPR results or subsequent excavation.

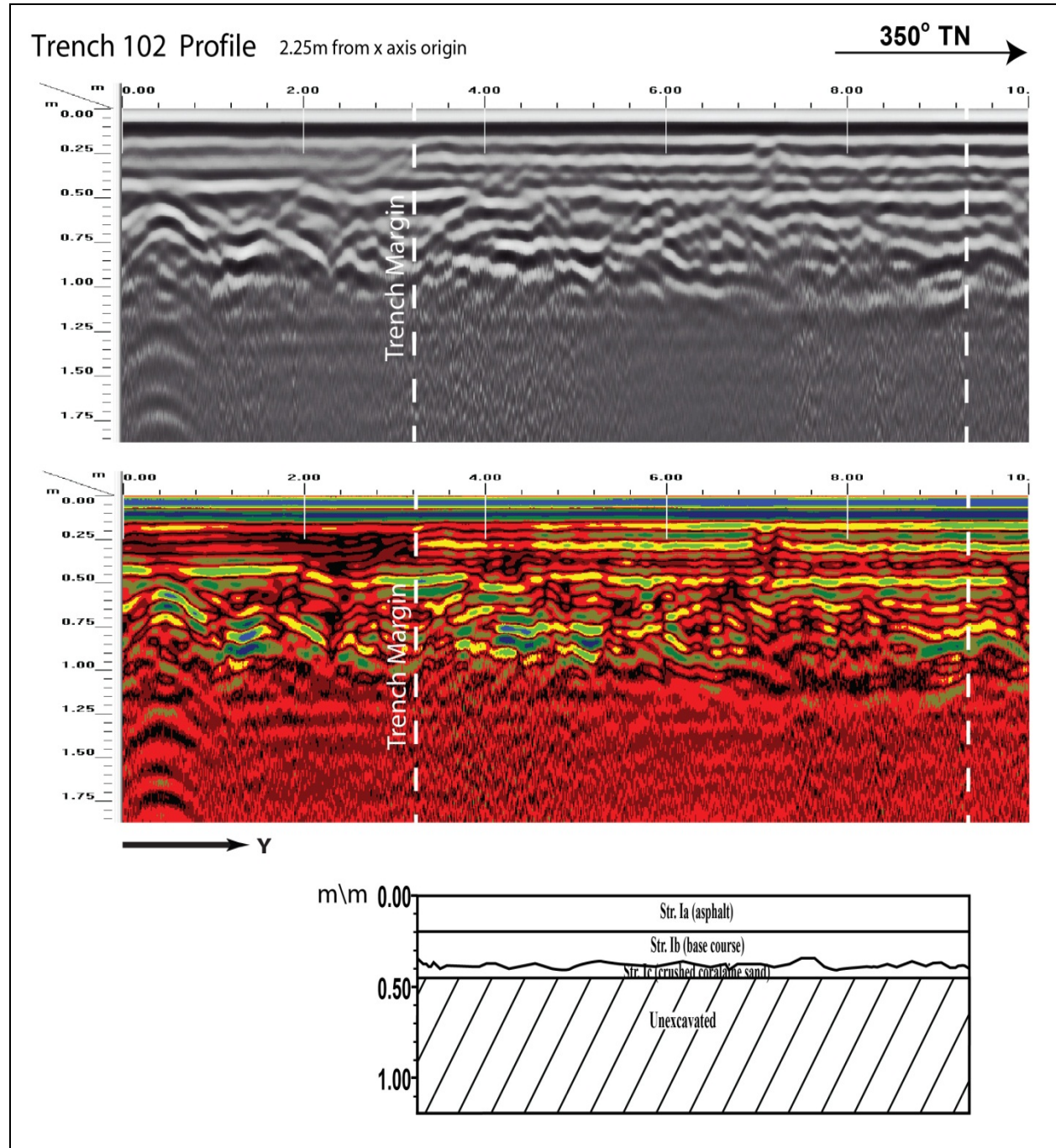


Figure 235. Visual comparison of excavated profile and GPR signal profile of T-102

Test Excavation 103

T-103 measured 0.6 m by 6 m and was oriented northwest to southeast and was located within the road cut of Nimitz Highway in the southbound center lane, 51 m northwest of Nimitz Highway and Maunakea Street intersection. The GPR grid measured 2 m by 10 m with 25 cm spacing between Y-transects and 1 m spacing between X-transects. Utilities located near the excavation include a gas line 1.5 m east. No utilities transected the GPR grid or excavation location.

A review of amplitude slice maps indicated no linear features which might have indicated the presence of utilities. Reflectivity was relatively uniform throughout the grid and decreased with depth. A transition from higher reflectivity to lower reflectivity was observed at approximately 0.25 mbs and increases again around 0.75 mbs (Figure 236).

GPR depth profiles for T-103 identified horizontal banding, commonly associated with stratigraphic layering, throughout the survey area (Figure 237). This banding corresponded to variations of density and chemical composition within fill deposits. The profile also indicated a change in reflectivity which occurred around 0.15 mbs and again around 0.45 and 0.7 mbs. No utilities were observed in the profile. The maximum depth of clean signal return was approximately 1.0 mbs.

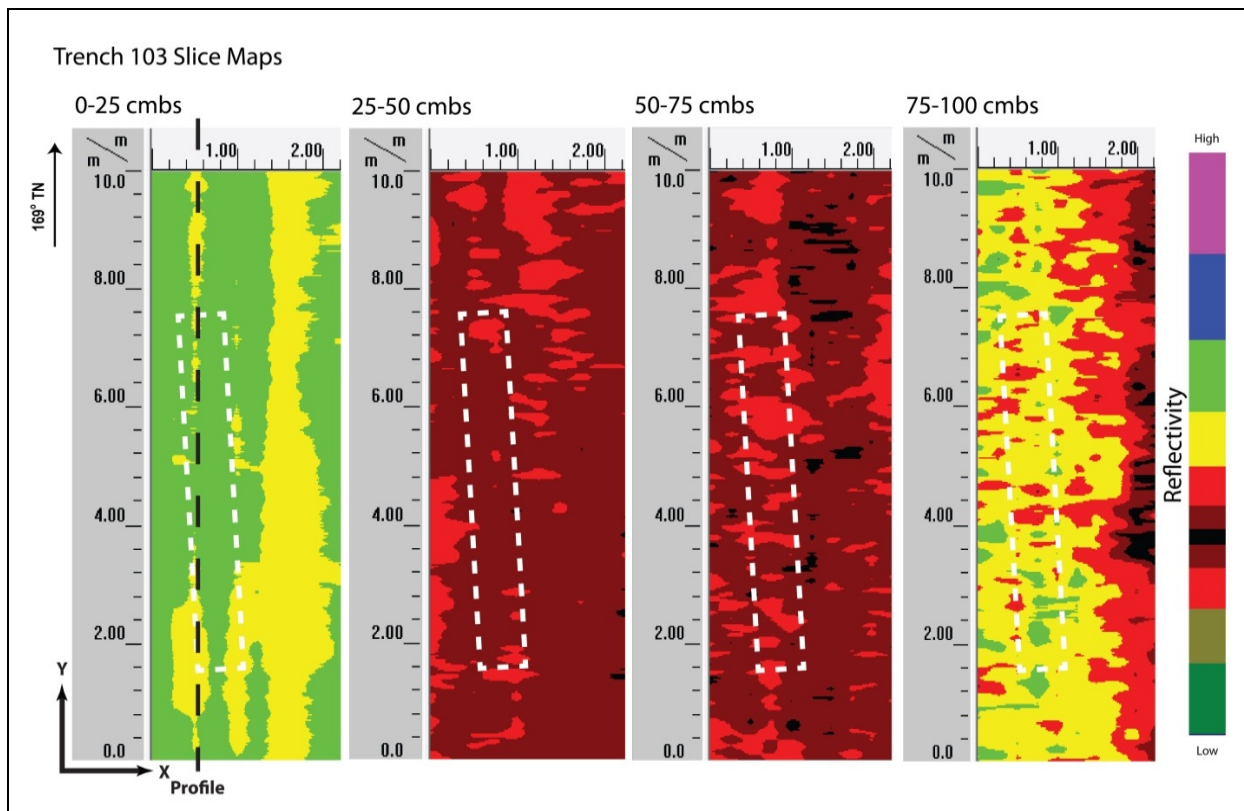


Figure 236. Slice maps of T-103 at 25 cm depth intervals

A visual comparison of the excavated profile and the GPR signal profile showed a strong correlation in stratigraphic transitions (Figure 237). Strata Ia to Id were clearly observed and occurred near the ground-truthed depths. Strata include a layer of asphalt on top of base course followed by crushed coralline sand and then a silty loam fill. No discrete objects or other stratigraphic transitions were observed in the GPR results or subsequent excavation.

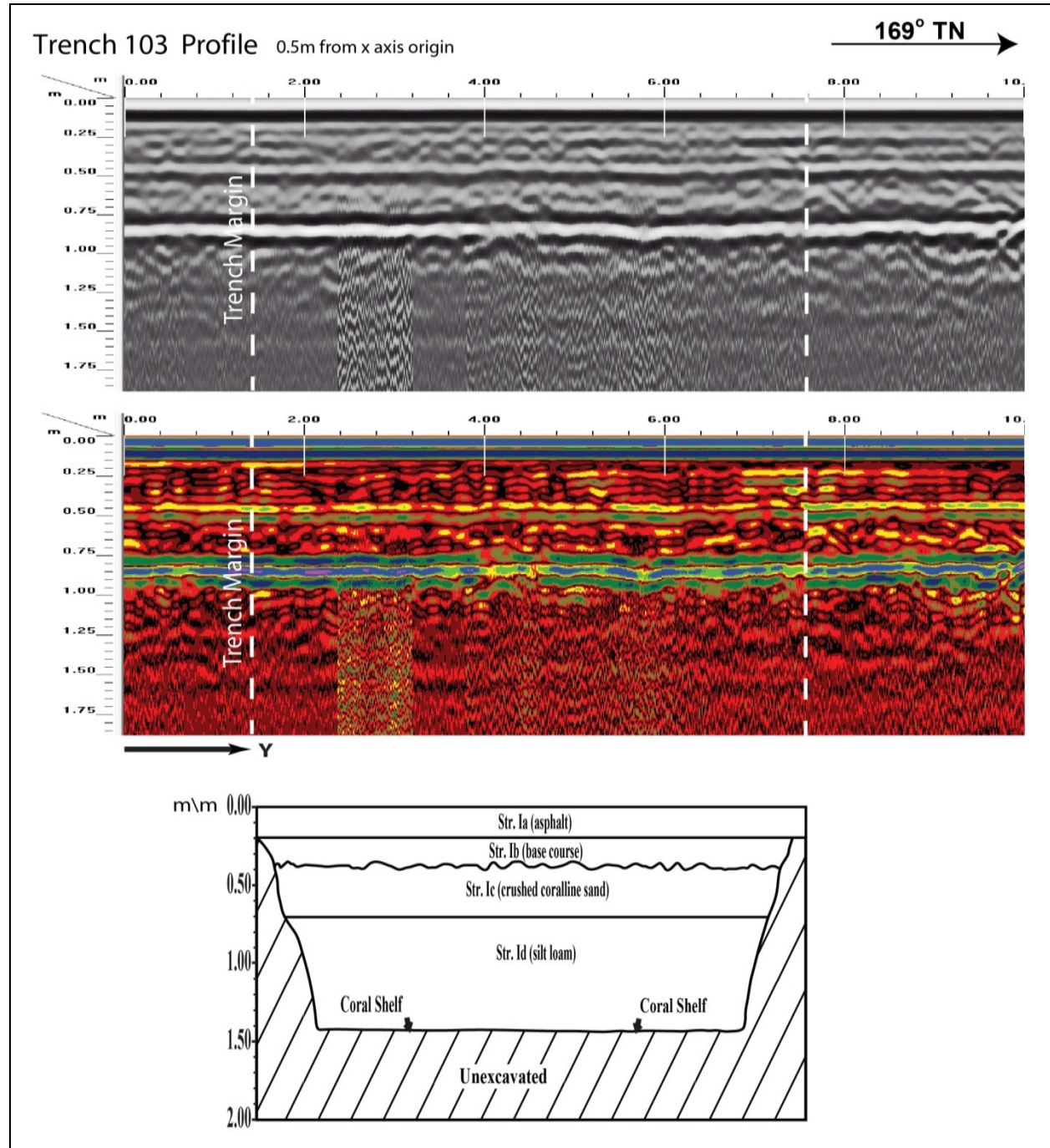


Figure 237. Visual comparison of excavated profile and GPR signal profile of T-103

Test Excavation 104

T-104 measured 0.6 m by 6 m and was oriented northwest to southeast and was located within the bike lane on Nimitz Highway, 3 m north of Nimitz Highway and Maunakea Street intersection. The GPR grid measured 2 m by 10 m with 25 cm spacing between Y-transects and 1 m spacing between X-transects. Utilities located near the excavation include electrical line 1 m west, sewer line 2.2 m east, water line 3.8 m east.

A review of amplitude slice maps indicated a linear feature but not within excavation boundaries. Reflectivity was relatively uniform throughout the grid and decreased with depth. A transition from higher reflectivity to lower reflectivity was observed at approximately 0.75 mbs (Figure 238).

GPR depth profiles for T-104 identified horizontal banding, commonly associated with stratigraphic layering, throughout the survey area (Figure 239). This banding corresponded to variations of density and chemical composition within fill deposits. The profile also indicated a change in reflectivity which occurred around 0.2 mbs. An anomaly was observed in the profile but not within excavation boundaries. The maximum depth of clean signal return was approximately 1.1 mbs.

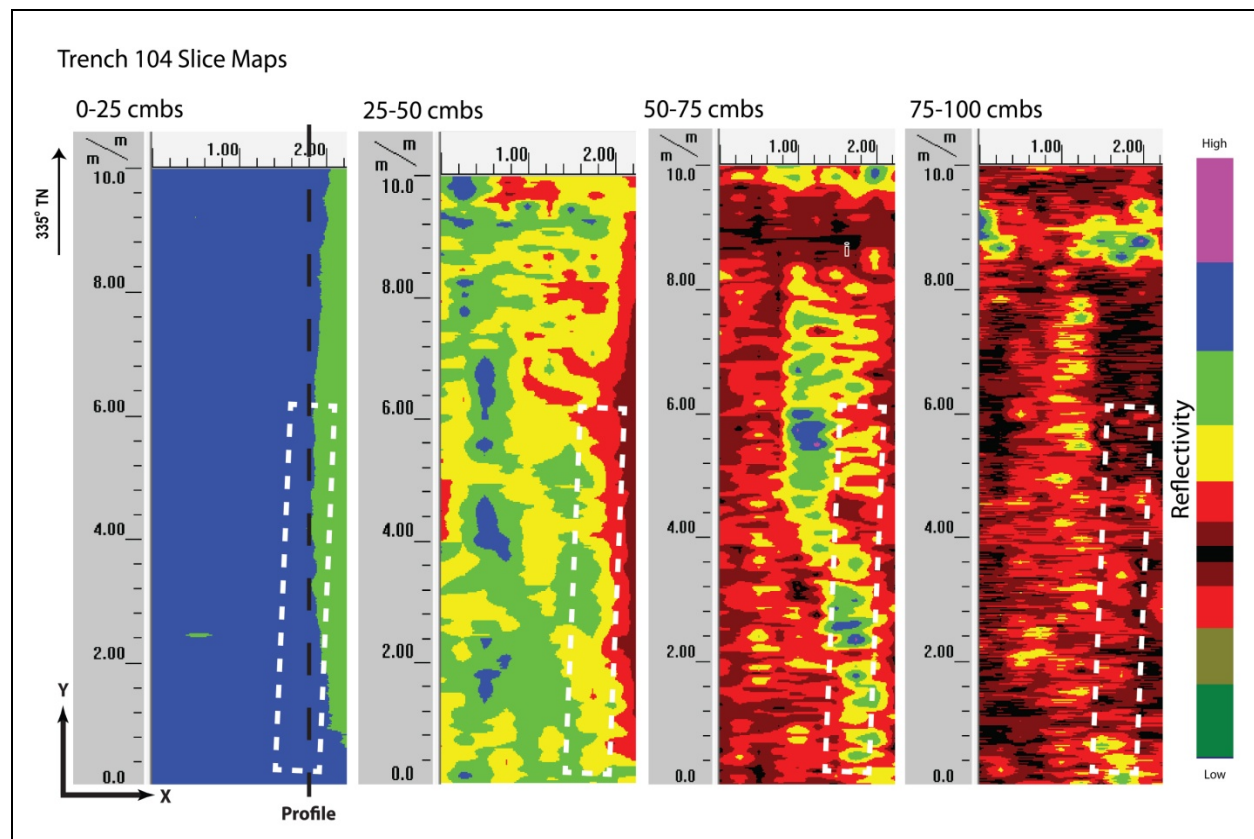


Figure 238. Slice maps of T-104 at 25 cm depth intervals

A visual comparison of the excavated profile and the GPR signal profile showed a strong correlation in stratigraphic transitions (Figure 239). Strata Ia to Ig were clearly observed and occurred at the ground-truthed depths. Strata Ia, Ib, If, and Ig were observed in the GPR profile but strata Ic through Ie were not individually discernible, possibly due to the fact that they were very thin layers of the compacted fill, but based on reflectivity and horizontal banding it was apparent that there were multiple layers of fill events. All other sediment transitions were below the maximum depth of clean signal return. No other discrete objects were observed in the GPR results or subsequent excavation.

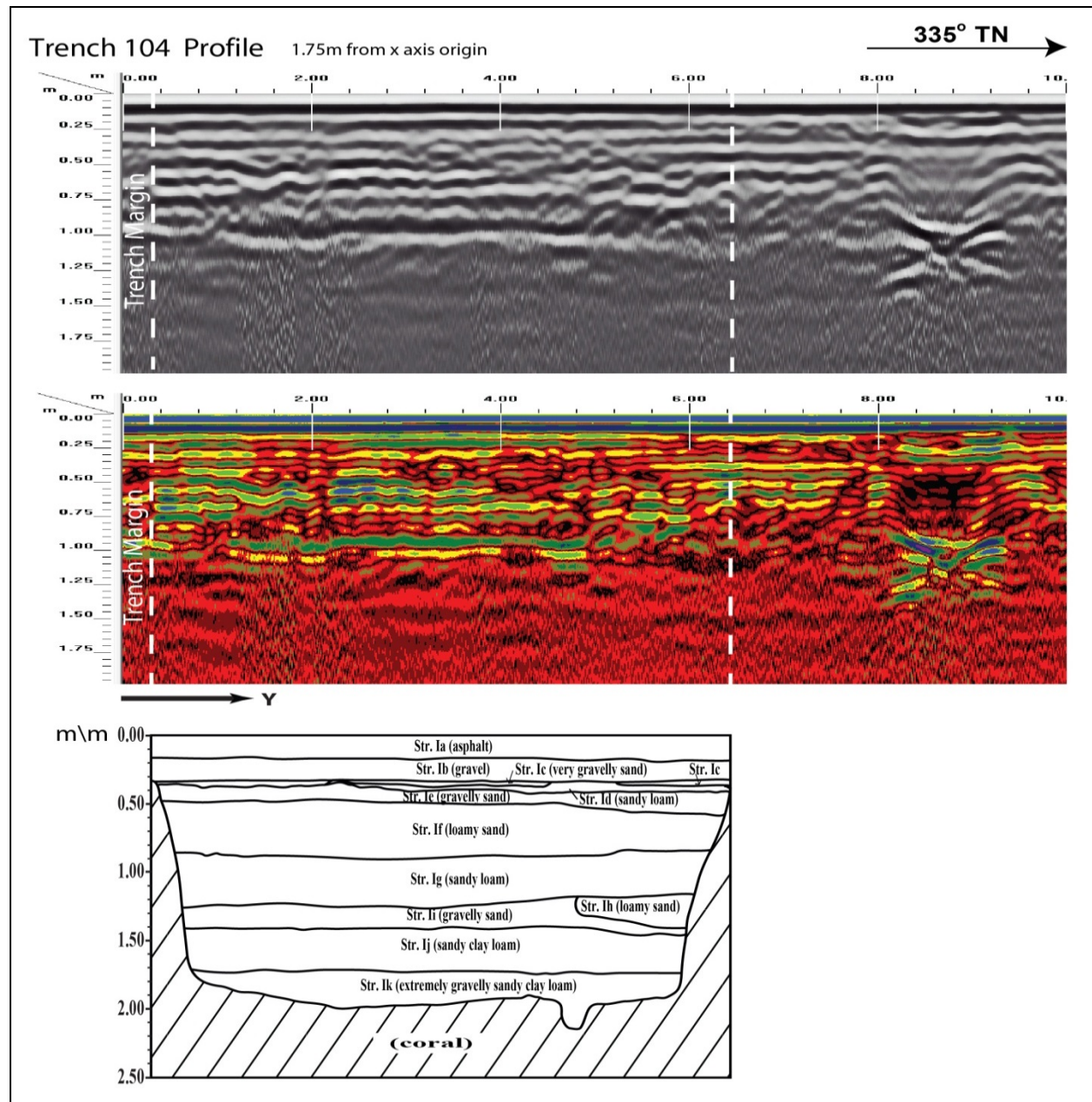


Figure 239. Visual comparison of excavated profile and GPR signal profile of T-104

Test Excavation 104A

T-104A measured 0.6 m by 6 m and was oriented northwest to southeast and was located within the bike lane on Nimitz Highway, 13 m northwest of Nimitz Highway and Maunakea Street intersection. The GPR grid measured 2.5 m by 9 m with 25 cm spacing between Y-transects and 1 m spacing between X-transects. Utilities located near the excavation include electric line 1.5 m west and 2.5 m east, sewer line 2 m east, and a gas line 3 m east.

A review of amplitude slice maps indicated no linear features which might have indicated the presence of utilities. Reflectivity was relatively uniform throughout the grid and decreased with depth. A transition from higher reflectivity to lower reflectivity was observed at approximately 0.25 mbs and increases again around 0.75 mbs (Figure 240).

GPR depth profiles for T-083 identified horizontal banding, commonly associated with stratigraphic layering, throughout the survey area (Figure 241). This banding corresponded to variations of density and chemical composition within fill deposits. The profile also indicated a change in reflectivity which occurred around 0.1 mbs and again around 0.4 mbs. No utilities were observed in the profile. The maximum depth of clean signal return was approximately 0.85 mbs.

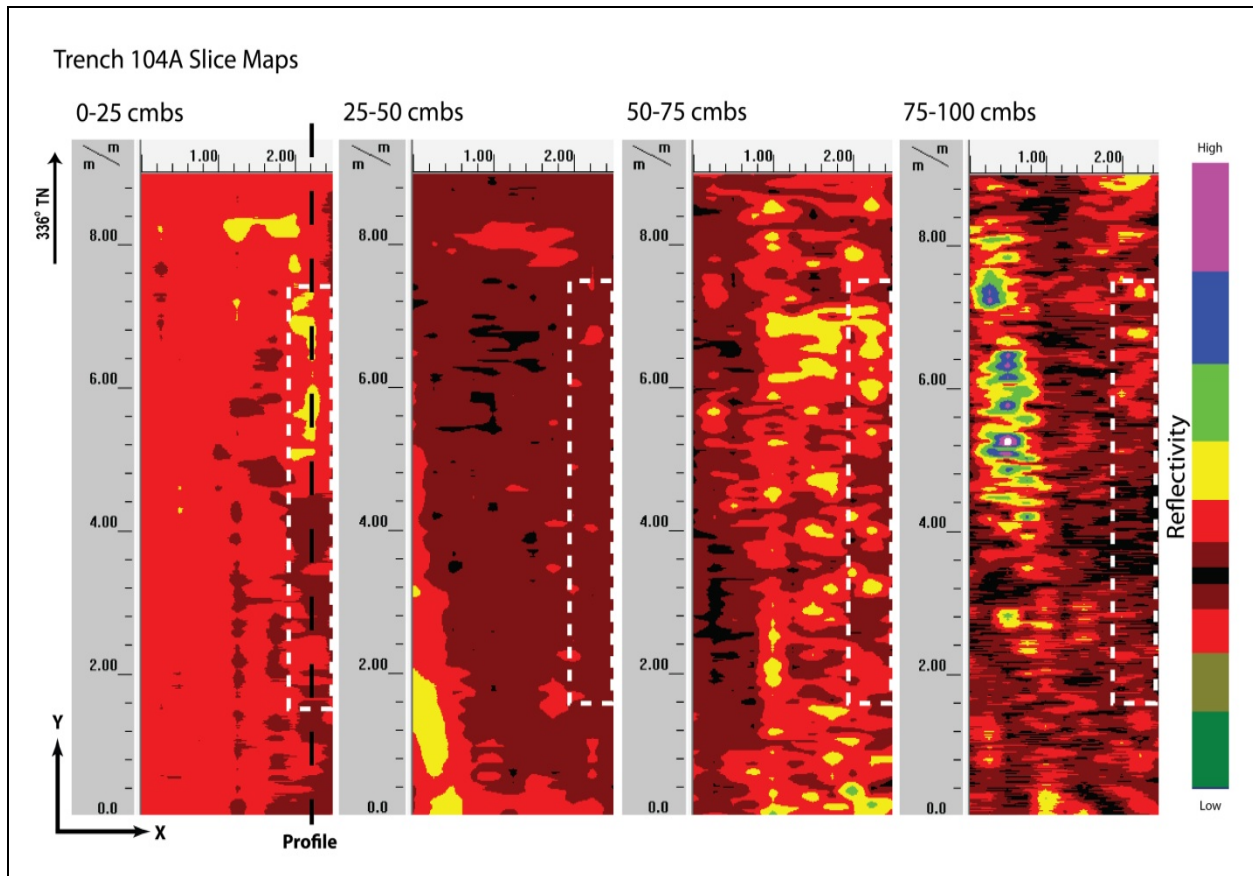


Figure 240. Slice maps of T-104A at 25 cm depth intervals

A visual comparison of the excavated profile and the GPR signal profile showed a strong correlation in stratigraphic transitions (Figure 241). Strata Ia to II were clearly observed and occurred at the ground-truthed depths. Textural changes in the form of multiple small hyperbolas were apparent in Stratum Id which was gravelly sandy loam fill. All other sediment transitions were below the maximum clean signal return depth. No discrete objects were observed in the GPR results or subsequent excavation.

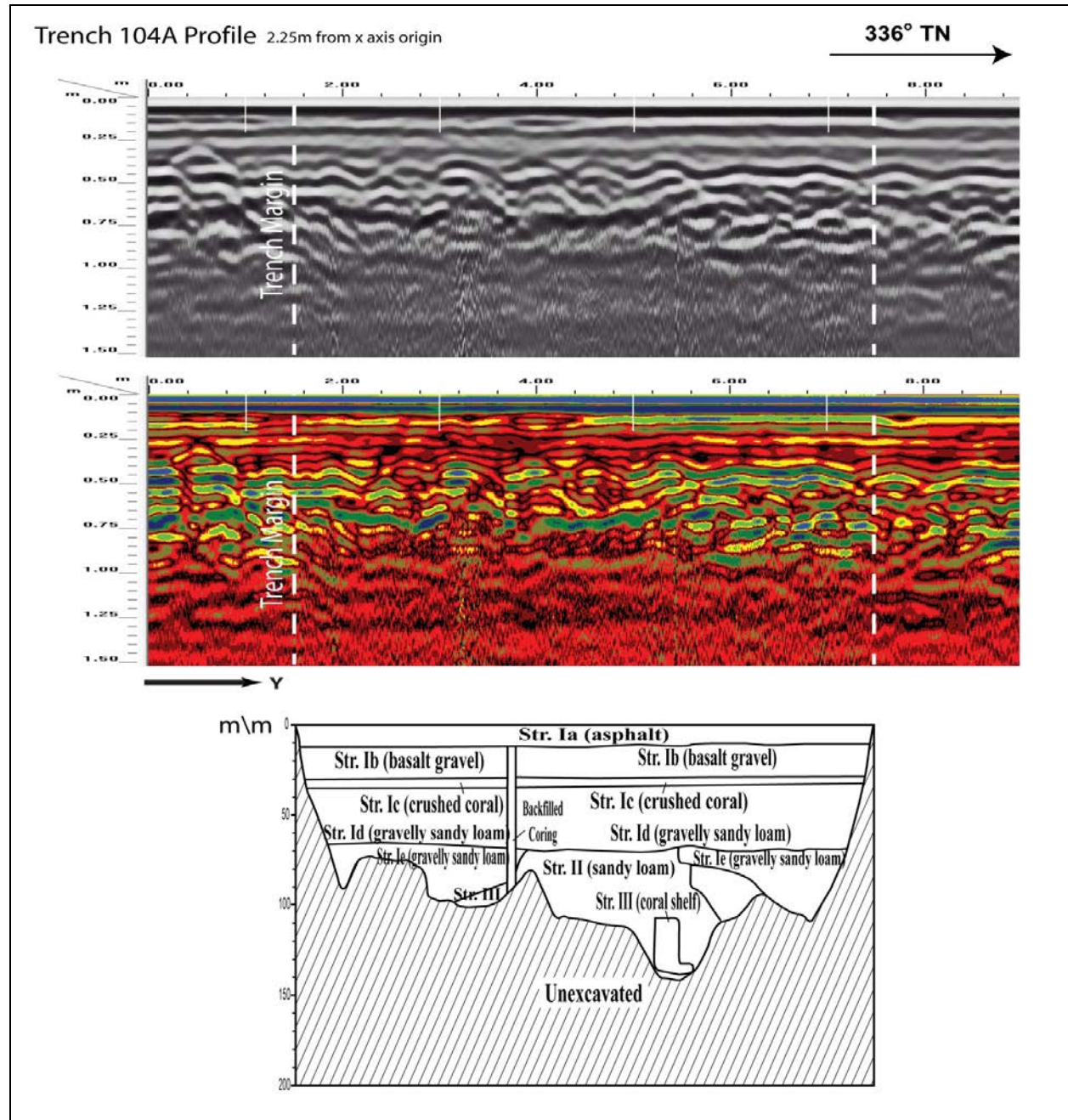


Figure 241. Visual comparison of excavated profile and GPR signal profile of T-104A

Test Excavation 105

T-105 measured 0.6 m by 6 m and was oriented northwest to southeast and was located within the center median on Nimitz Highway, 15 m southwest of Nimitz Highway and Smith Street intersection. The GPR grid measured 3 m by 10 m with 25 cm spacing between Y-transects and 1 m spacing between X-transects. Utilities located near the excavation include fuel line 1 m west and 1 m east, electrical cable .6 m south. A 12" utility pipe was encountered 0.93 mbs along the entire length of the excavation.

A review of amplitude slice maps indicated a linear feature although it does not correspond to the large utility that was encountered during excavation. Reflectivity was relatively uniform throughout the grid and decreased with depth. A transition from higher reflectivity to lower reflectivity was observed at approximately 0.5 mbs (Figure 242).

GPR depth profiles for T-105 identified horizontal banding, commonly associated with stratigraphic layering, throughout the survey area (Figure 243). This banding corresponded to variations of density and chemical composition within fill deposits. The profile also indicated a change in reflectivity which occurred around 0.2 mbs. An anomaly was observed in the profile but not within excavation boundaries and the large utility that was encountered was not observed in the profile. The maximum depth of clean signal return was approximately 1.0 mbs.

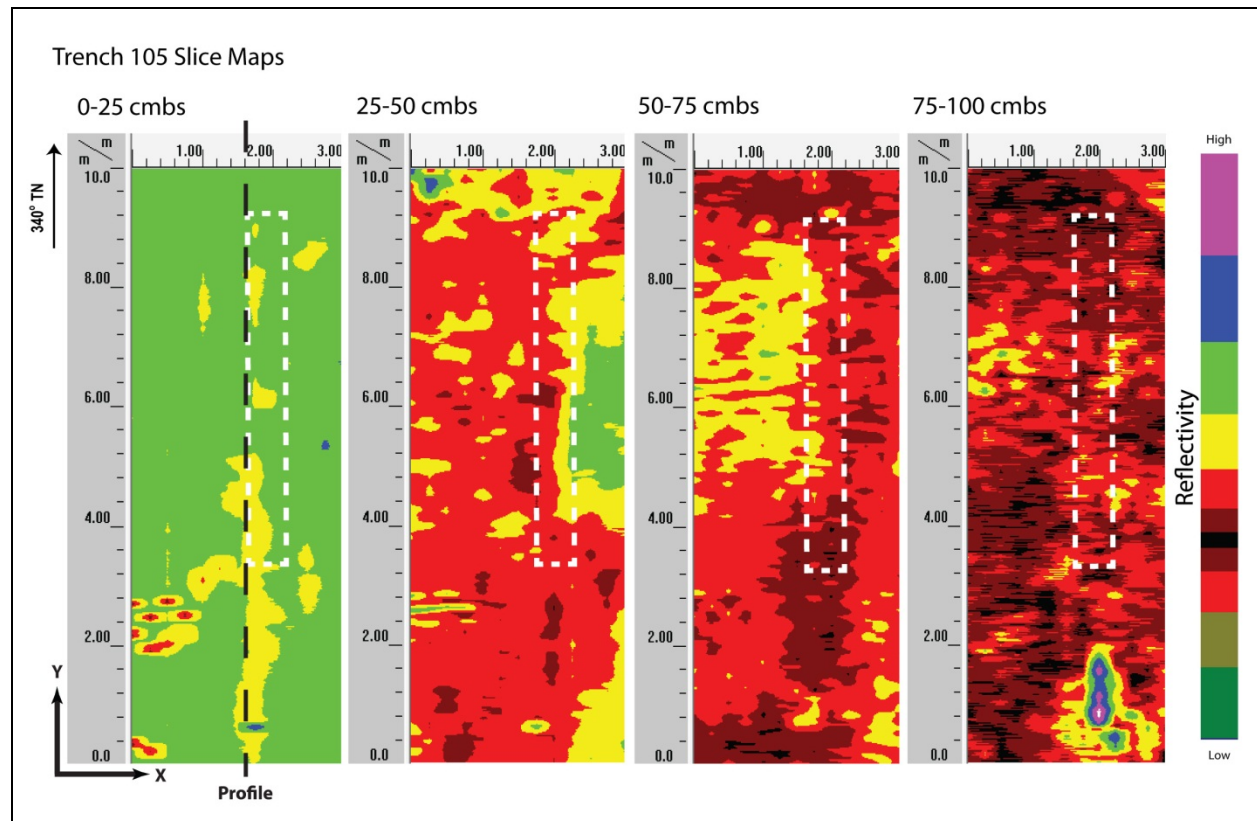


Figure 242. Slice maps of T-105 at 25 cm depth intervals

A visual comparison of the excavated profile and the GPR signal profile showed a strong correlation in stratigraphic transitions (Figure 243). Strata Ia to Id were clearly observed and occurred at the ground-truthed depths. Strata include a thick layer of asphalt on top of gravel followed by crushed coralline sand fill and then sand fill. A large utility pipe was found 0.93 mbs. This pipe did not show up on the profile or slice maps. This may be due to the fact that it was bordering on the maximum clean signal return depth or the pipe could have been empty. No other discrete objects or other stratigraphic transitions were observed in the GPR results or subsequent excavation.

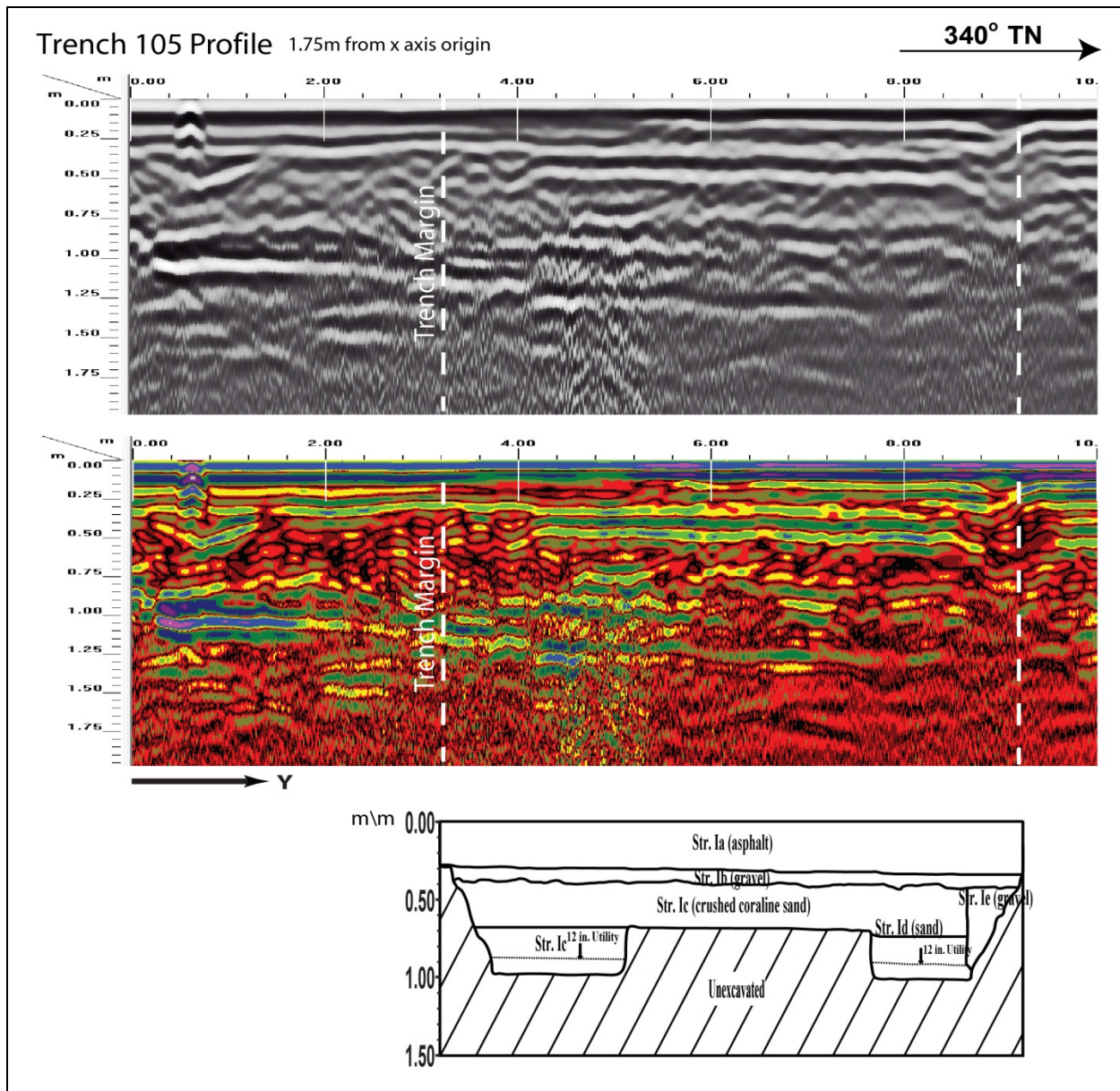


Figure 243. Visual comparison of excavated profile and GPR signal profile of T-105

Test Excavation 106

T-106 measured 0.6 by 6 m and was oriented northwest to southeast and was located within the road cut of Nimitz Highway, 30 m southwest of Nimitz Highway and Smith Street intersection. The GPR grid measured 3 m by 10 m with 25 cm spacing between Y-transects and 1 m spacing between X-transects. Utilities located near the excavation include fuel line 1.2 m west and 2.2 m east, electrical line 6.3 m northeast. An 8" utility pipe was encountered 1.21 mbs along the entire length of the excavation and a 4" utility pipe 0.55 mbs and was perpendicular in the northern end of the excavation.

A review of amplitude slice maps indicated a linear feature but it was not encountered during excavation. Reflectivity was relatively uniform throughout the grid and decreased with depth except the linear feature. A transition from higher reflectivity to lower reflectivity was observed at approximately 0.25 mbs (Figure 244).

GPR depth profiles for T-106 identified horizontal banding, commonly associated with stratigraphic layering, throughout the survey area (Figure 245). This banding corresponded to variations of density and chemical composition within fill deposits. The profile also indicated a change in reflectivity which occurred around 0.1 mbs. An anomaly was observed in the profile but was not encountered during excavation and the two utilities that were encountered were not observed in the GPR profile. The maximum depth of clean signal return was approximately 1.0 mbs.

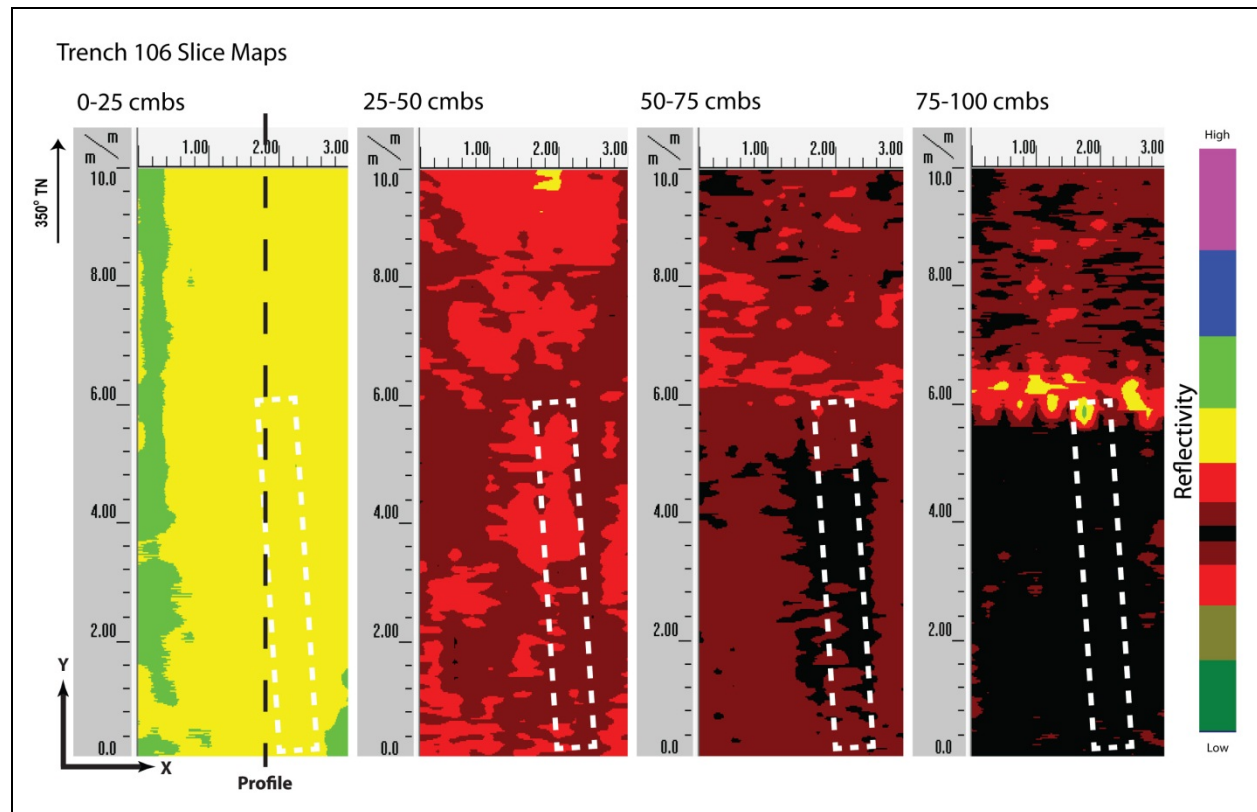


Figure 244. Slice maps of T-106 at 25 cm depth intervals

A visual comparison of the excavated profile and the GPR signal profile showed a moderate correlation in stratigraphic transitions (Figure 245). Strata Ia to Ic were all clearly observed and occurred near the ground-truthed depths. Two utility pipes were found 0.55 and 1.21 mbs. These two pipes did not show up on the profile or slice maps. This may be due to the fact that the pipe was empty and one pipe was below the maximum depth of clean signal return. No other discrete objects were observed in the GPR results or subsequent excavation.

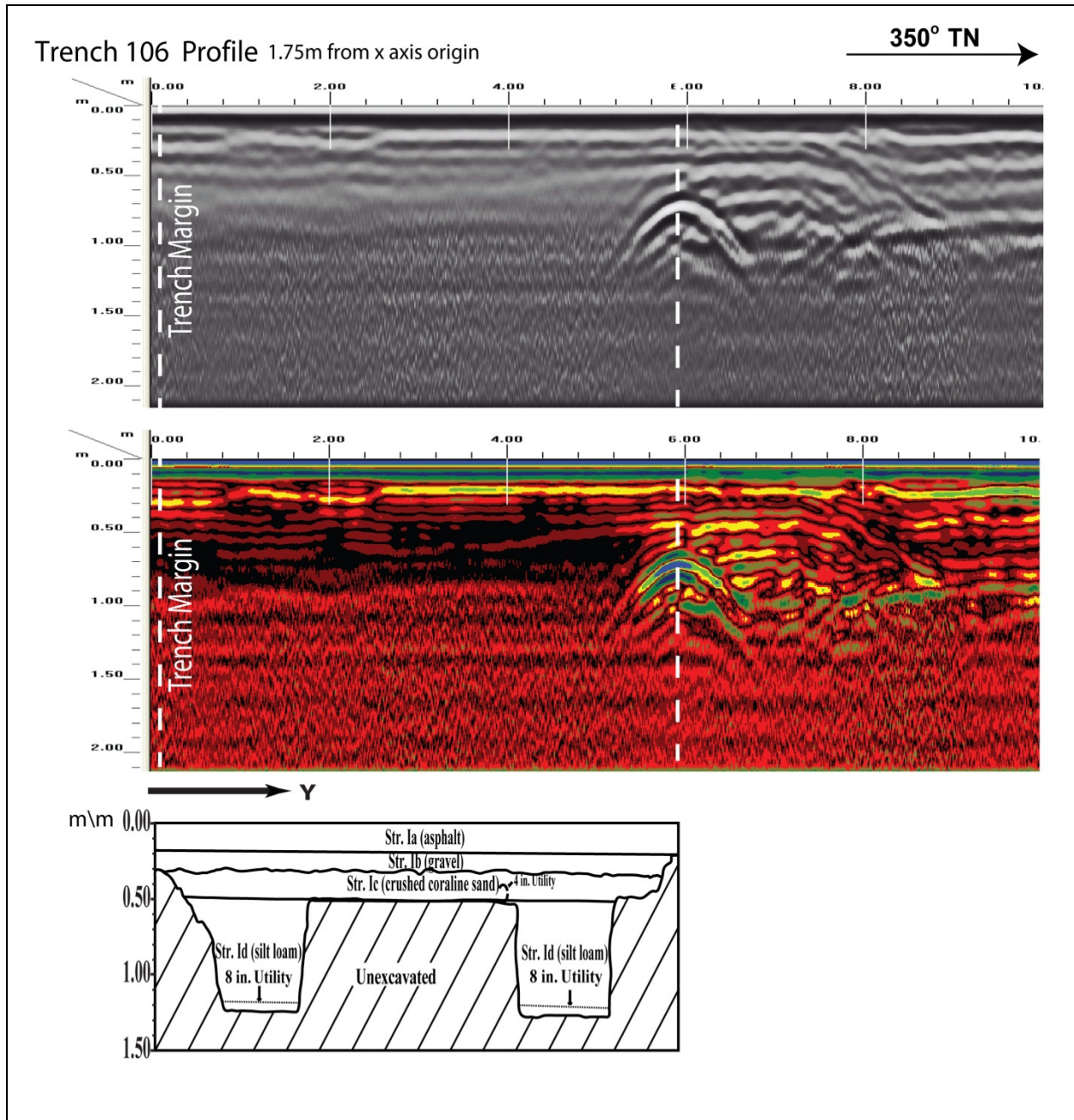


Figure 245. Visual comparison of excavated profile and GPR signal profile of T-106

Test Excavation 107

T-107 measured 0.6 m by 6 m and was oriented north to south and was located within the road cut of Nimitz Highway in the southbound lane, 40 m northwest of Nimitz Highway and Bethel Street intersection. The GPR grid measured 3 m by 10 m with 25 cm spacing between Y-transects and 1 m spacing between X-transects. Utilities located near the excavation included: sewer line 1.2 m east and 2.7 m west. Two box culverts were encountered 1.3 mbs along the entire length of the excavation.

A review of amplitude slice maps indicated no linear features although two culverts were encountered but below clean signal return. Reflectivity was relatively uniform throughout the grid and decreased with depth. A transition from higher reflectivity to lower reflectivity was observed at approximately 0.25 mbs and increases again around 0.75 mbs (Figure 246).

GPR depth profiles for T-107 identified horizontal banding, commonly associated with stratigraphic layering, throughout the survey area (Figure 247). This banding corresponded to variations of density and chemical composition within fill deposits. The profile also indicated a change in reflectivity which occurred around 0.25 mbs. No utilities were observed in the profile although two culverts were encountered during excavation. The maximum depth of clean signal return was approximately 1.1 mbs.

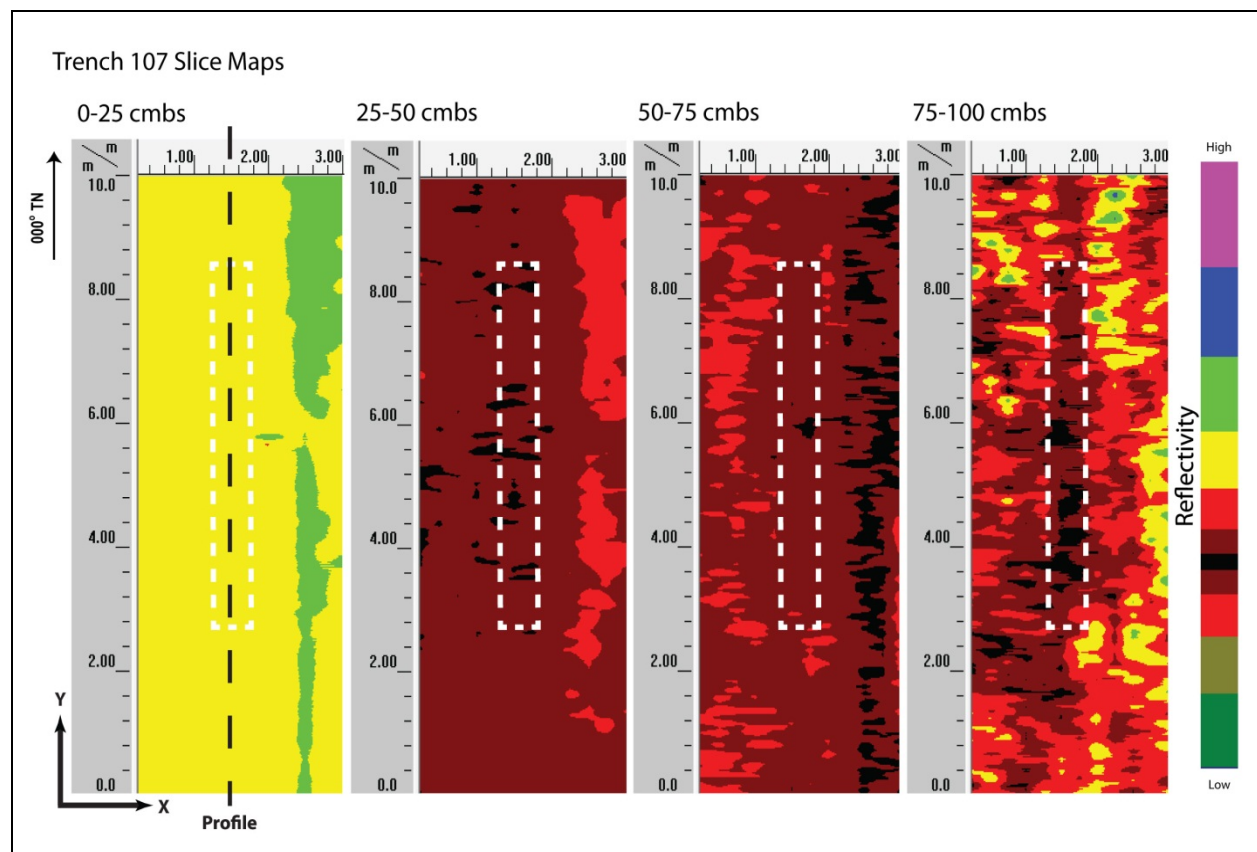


Figure 246. Slice maps of T-107 at 25 cm depth intervals

A visual comparison of the excavated profile and the GPR signal profile showed a strong correlation in stratigraphic transitions (Figure 247). Strata Ia to Id were clearly observed and occurred at the ground-truthed depths. Strata included: asphalt, base course, crushed coralline sand fill, and sandy clay fill. Two box culverts were found 1.33 mbs. These box culverts did not show up on the profile or slices due to the fact that they were below the maximum clean signal return depth. No other discrete objects or stratigraphic transitions were observed in the GPR results or subsequent excavation.

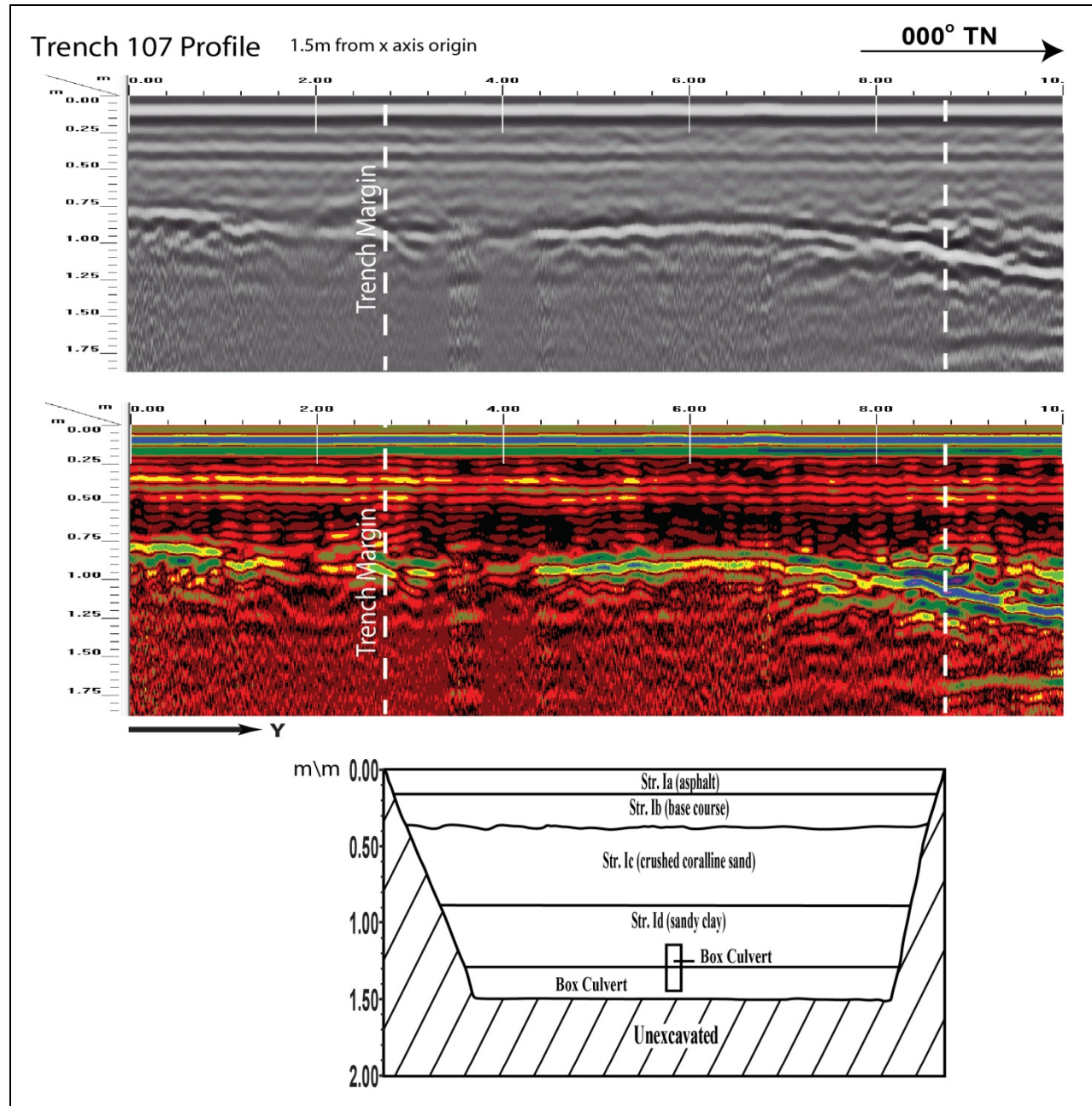


Figure 247. Visual comparison of excavated profile and GPR signal profile of T-107

Test Excavation 108

T-108 measured 0.8 m by 5 m and was oriented north to south and was located within the center of the road cut of southbound Nimitz Highway, 10 m west of Nimitz Highway and Bethel Street intersection. The GPR grid measured 3 m by 8 m with 25 cm spacing between Y-transects and 1 m spacing between X-transects. Utilities located near the excavation include electrical line 0.5 m east and 1.1 m south, gas line 1.4 m west. A 2" concrete pipe was encountered 1.2 mbs and a 2" irrigation line encountered approximately 0.1 mbs in the northern end of the excavation.

A review of amplitude slice maps indicated a linear features but not within excavation boundaries. Reflectivity was relatively uniform throughout the grid and decreased with depth. A transition from higher reflectivity to lower reflectivity was observed at approximately 0.5 mbs (Figure 248).

GPR depth profiles for T-108 identified horizontal banding, commonly associated with stratigraphic layering, throughout the survey area (Figure 249). This banding corresponded to variations of density and chemical composition within fill deposits. The profile also indicated a change in reflectivity which occurred around 0.25 mbs and again around 0.75 mbs. An anomaly was observed in the profile but does not correspond to the utilities encountered during excavation. The maximum depth of clean signal return was approximately 1.0 mbs.

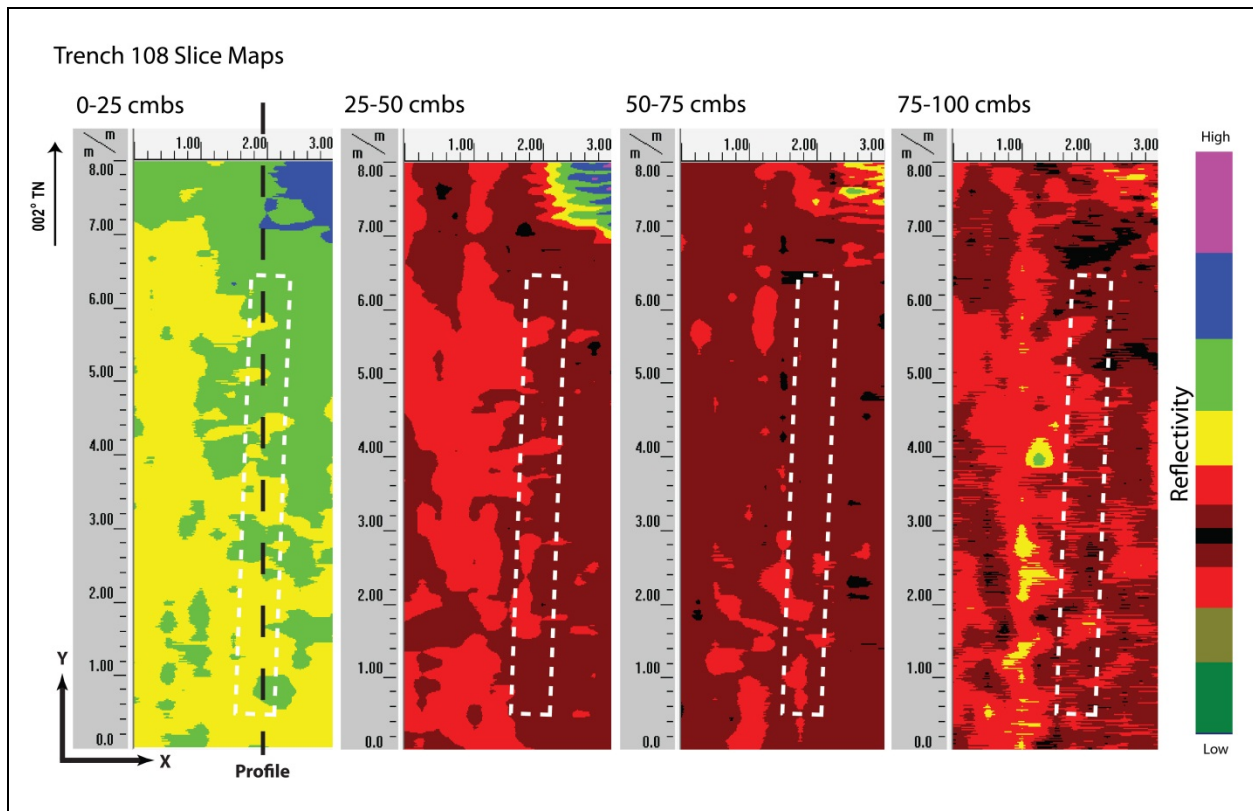


Figure 248. Slice maps of T-108 at 25 cm depth intervals

A visual comparison of the excavated profile and the GPR signal profile showed a strong correlation in stratigraphic transitions (Figure 249). Strata Ia to Id were clearly observed and occurred at the ground-truthed depths. Strata included a layer of silt loam fill on top of crushed coralline sand fill followed by sandy silt loam fill down to 1.3 mbs. A 2" concrete utility line was found 1.2 mbs. This pipe did not show up on the profile or on the slice maps. This was due to the fact that this was below the maximum clean signal return depth. No other discrete objects or stratigraphic transitions were observed in the GPR results or subsequent excavation.

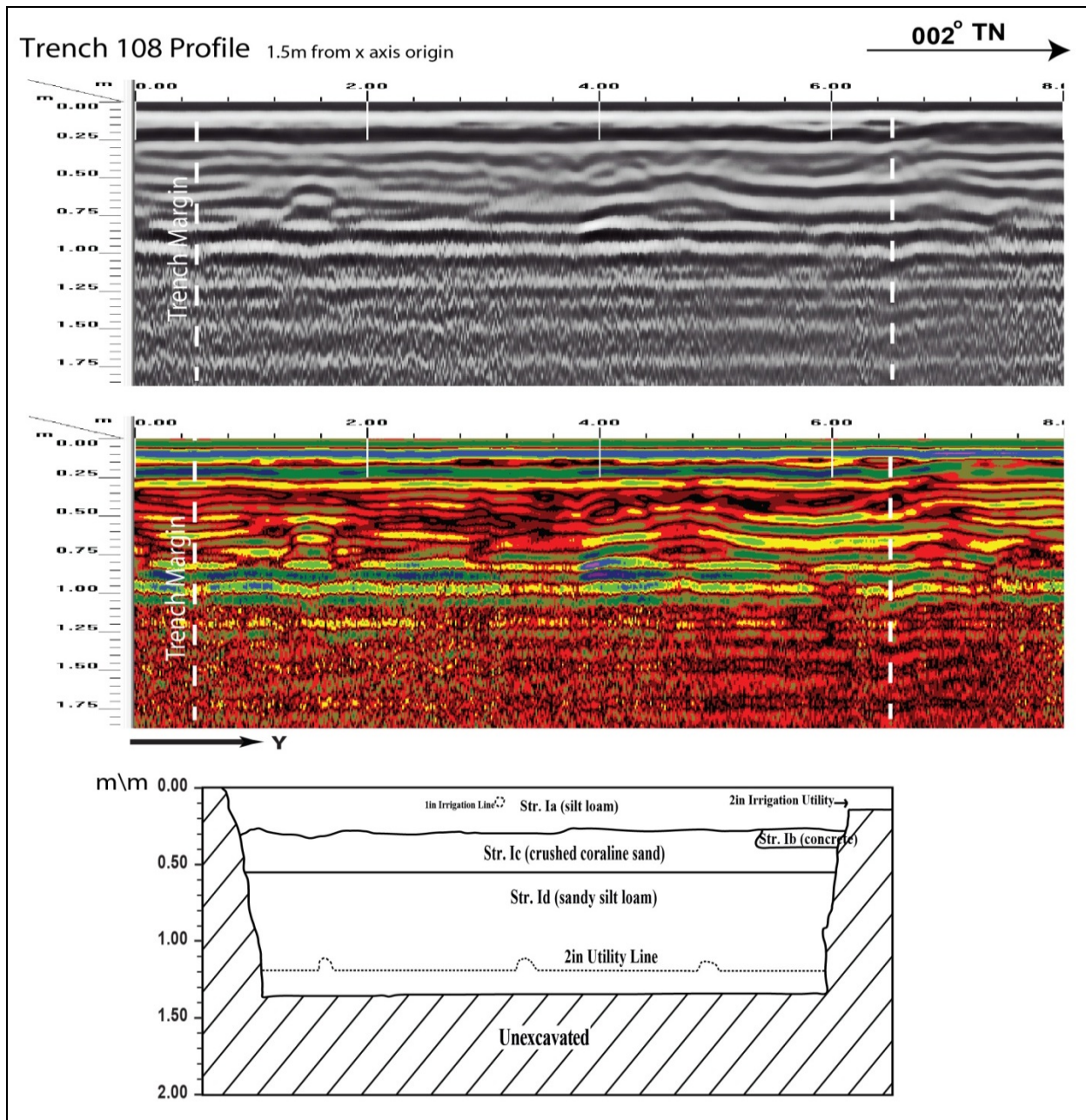


Figure 249. Visual comparison of excavated profile and GPR signal profile of T-108

Test Excavation 109

T-109 measured 0.6 m by 6 m and was oriented north to south and was located within the road cut of South Nimitz Highway, 25 m west of Nimitz Highway and Queen Street intersection. The GPR grid measured 3 m by 10 m with 25 cm spacing between Y-transects and 1 m spacing between X-transects. Utilities located near the excavation include a fuel line 1.2 m east. No utilities transected the GPR grid or excavation location.

A review of amplitude slice maps indicated no linear features which might have indicated the presence of utilities. Reflectivity was relatively uniform throughout the grid and decreased with depth. A transition from higher reflectivity to lower reflectivity was observed at approximately 0.75 mbs (Figure 250).

GPR depth profiles for T-109 identified horizontal banding, commonly associated with stratigraphic layering, throughout the survey area (Figure 251). This banding corresponded to variations of density and chemical composition within fill deposits. The profile also indicated a change in reflectivity which occurred around 0.1 mbs. An anomaly was observed in the profile but was not encountered during excavation. The maximum depth of clean signal return was approximately 1.0 mbs.

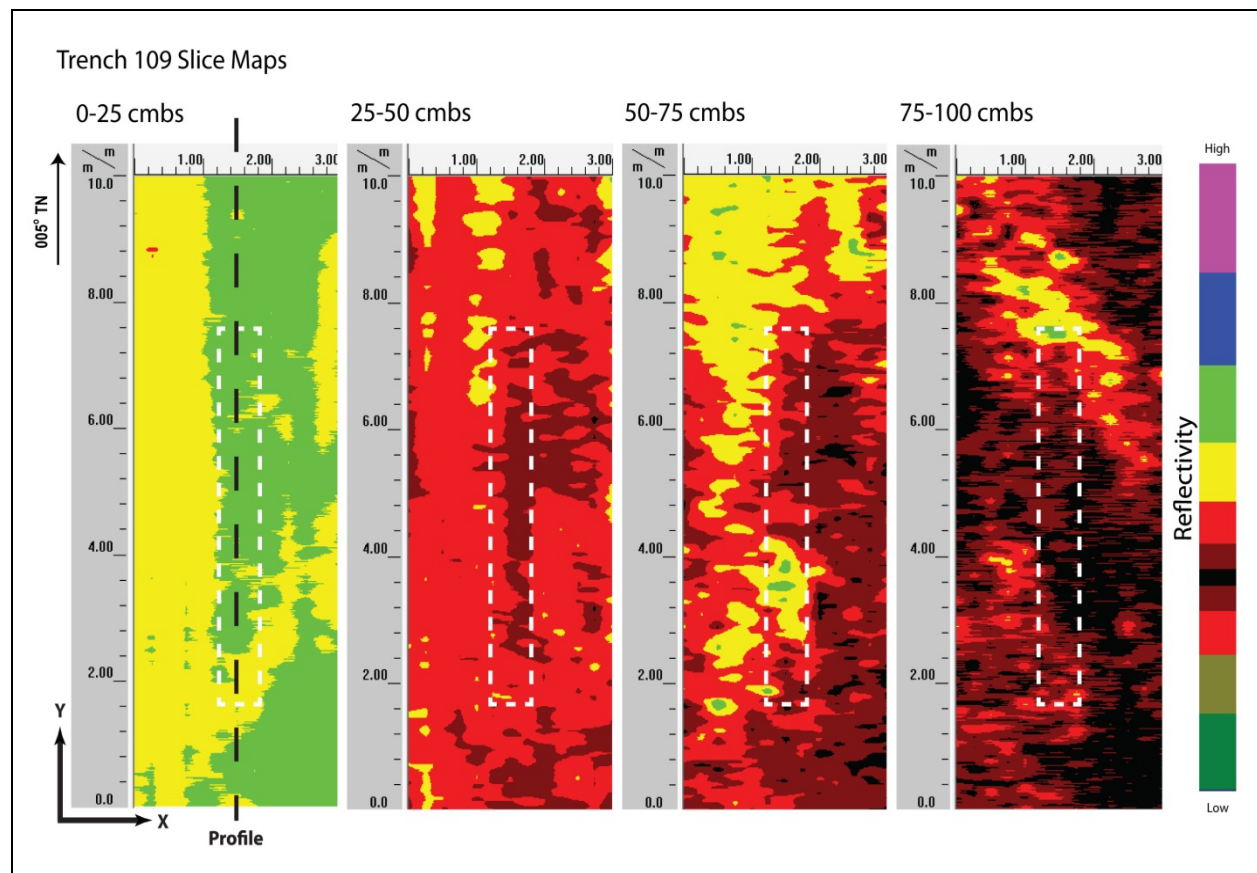


Figure 250. Slice maps of T-109 at 25 cm depth intervals

A visual comparison of the excavated profile and the GPR signal profile showed a strong correlation in stratigraphic transitions (Figure 251). Strata Ia to Ic were clearly observed and occurred at the ground-truthed depths. Textural changes in the form of multiple small hyperbolas were apparent in Stratum Ic which was crushed coral sand. All other sediment transitions were below the maximum depth of clean signal return. No discrete objects were observed in the GPR results or subsequent excavation.

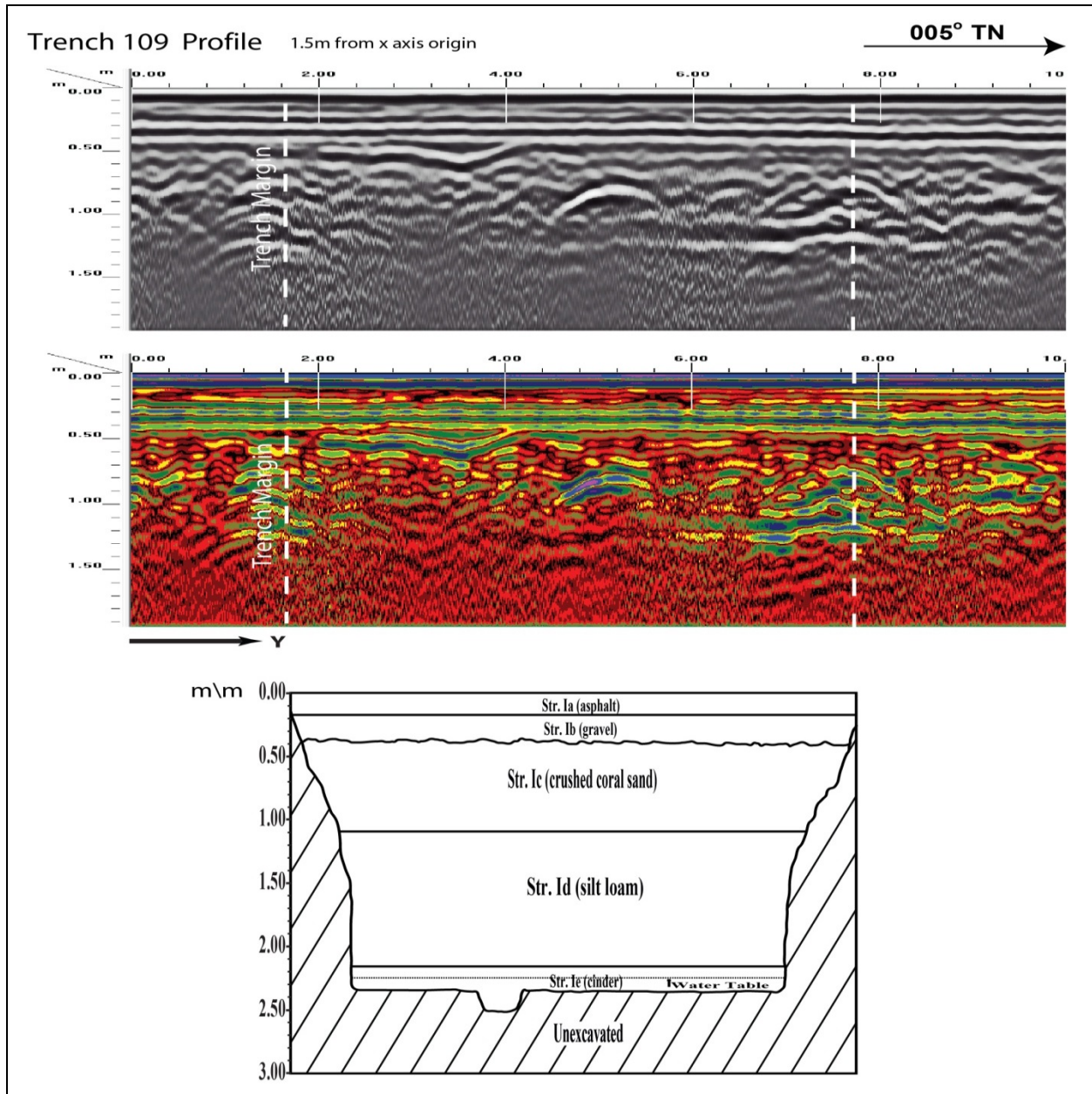


Figure 251. Visual comparison of excavated profile and GPR signal profile of T-109

Test Excavation 110

T-110 measured 0.9 m by 7 m and was oriented north to south and was located within the road cut of Nimitz Highway in the northbound lane, 15 m north of Nimitz Highway and Fort Street Mall intersection. The GPR grid measured 3 m by 10 m with 25 cm spacing between Y-transects and 1 m spacing between X-transects. Utilities located near the excavation include water drain 2.5 m east and a water line 4 m west. No utilities transected the GPR grid or excavation location.

A review of amplitude slice maps indicated no linear features which might have indicated the presence of utilities. Reflectivity was relatively uniform throughout the grid and decreased with depth. A transition from higher reflectivity to lower reflectivity was observed at approximately 0.25 mbs (Figure 252).

GPR depth profiles for T-110 identified horizontal banding, commonly associated with stratigraphic layering, throughout the survey area (Figure 253). This banding corresponded to variations of density and chemical composition within fill deposits. The profile also indicated a change in reflectivity which occurred around 0.15 mbs. No utilities were observed in the profile. The maximum depth of clean signal return was approximately 0.9 mbs.

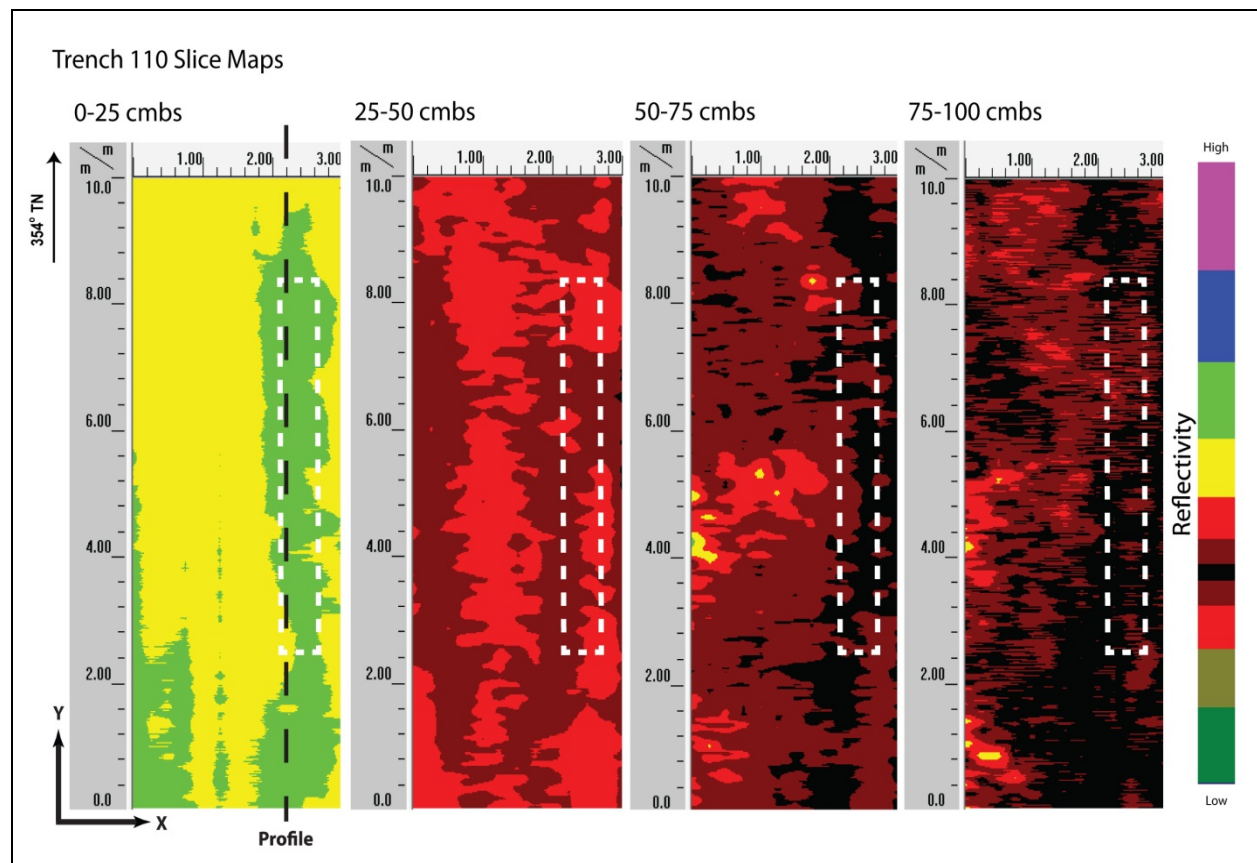


Figure 252. Slice maps of T-110 at 25 cm depth intervals

A visual comparison of the excavated profile and the GPR signal profile showed a moderate correlation in stratigraphic transitions (Figure 253). Strata Ia and Ic were all clearly observed and occurred near the ground-truthed depths. Strata included a layer of asphalt on top of base course followed by sandy silt loam fill and then a natural layer of cinder. No discrete objects or other stratigraphic transitions were observed in the GPR results or subsequent excavation.

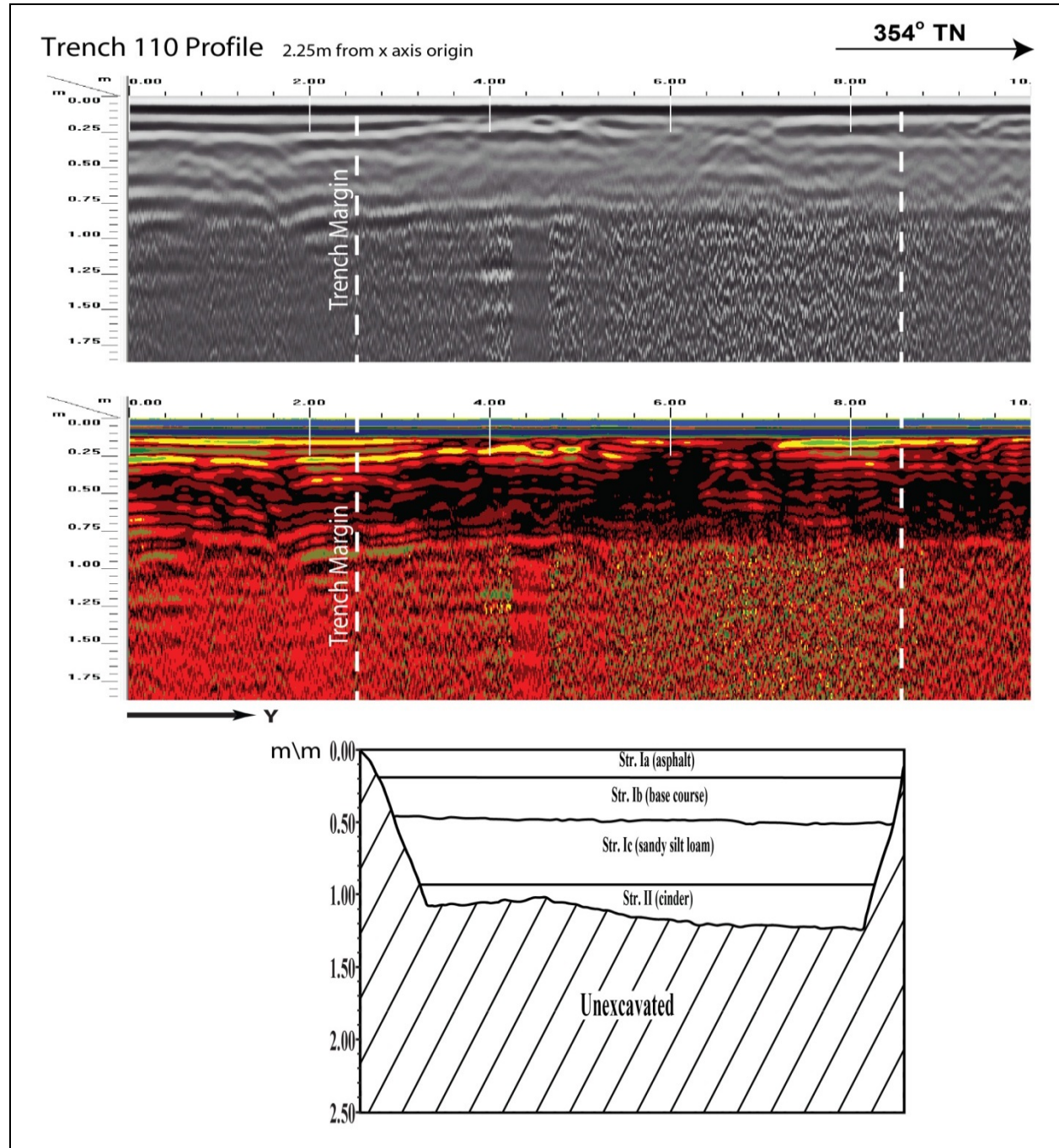


Figure 253. Visual comparison of excavated profile and GPR signal profile of T-110

Test Excavation 111

T-111 measured 0.8 m by 7 m and was oriented northwest to southeast and was located within the road cut of Nimitz Highway in the southbound lane, 19 m south of Nimitz Highway and Fort Street Mall intersection. The GPR grid measured 3 m by 10 m with 25 cm spacing between Y-transects and 1 m transects between X-transects. Utilities located near the excavation include a fuel line 4 m northeast. A utility was encountered 0.78 mbs in the southern end of the excavation.

A review of amplitude slice maps indicated several linear features but not within excavation boundaries and none correspond to the utility pipe encountered during excavation. Reflectivity was relatively uniform throughout the grid and decreased with depth except for the linear features. A transition from higher reflectivity to lower reflectivity was observed at approximately 0.75 mbs (Figure 254).

GPR depth profiles for T-111 identified horizontal banding, commonly associated with stratigraphic layering, throughout the survey area (Figure 255). This banding corresponded to variations of density and chemical composition within fill deposits. The profile also indicated a change in reflectivity which occurred around 0.15 mbs and again around 0.4 mbs. An anomaly was observed in the profile and it corresponded to the utility that was encountered during excavation. The maximum depth of clean signal return was approximately 1.25 mbs.

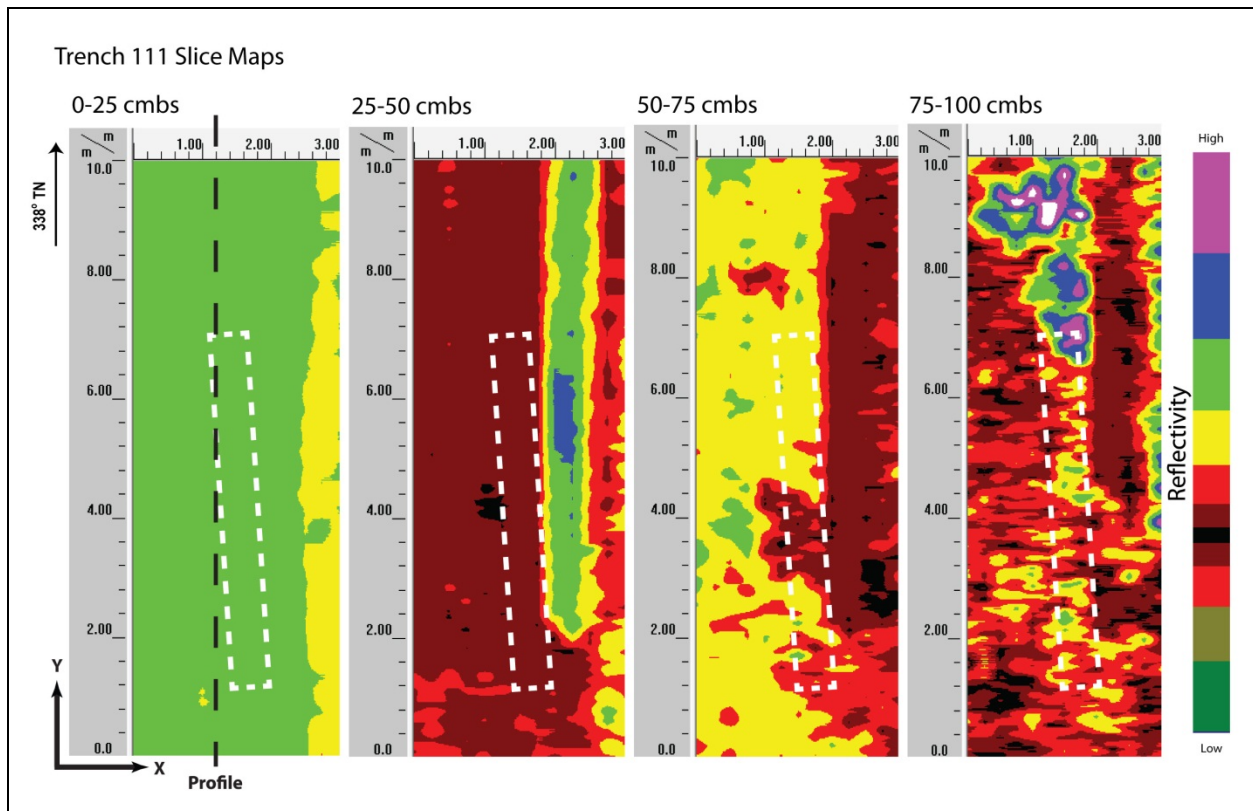


Figure 254. Slice maps of T-111 at 25 cm depth intervals

A visual comparison of the excavated profile and the GPR signal profile showed a strong correlation in stratigraphic transitions (Figure 255). Strata Ia and Ib were clearly observed and occurred at the ground-truthed depths. Strata included a thick layer of asphalt on top of sandy loam fill. A utility pipe was found 0.78 mbs. This pipe corresponded to a hyperbola anomaly observed in the profile. No discrete objects or other stratigraphic transitions were observed in the GPR results or subsequent excavation.

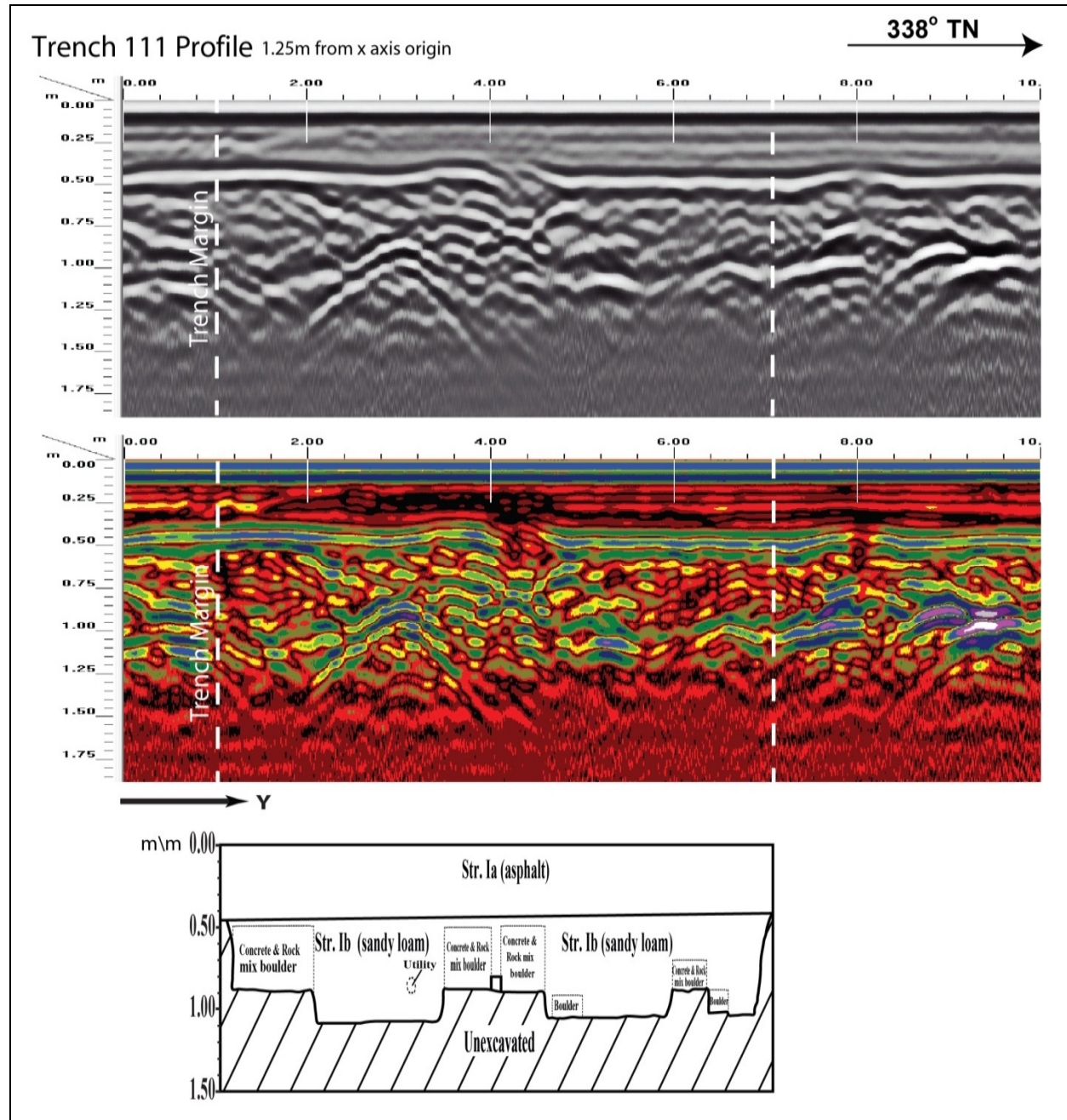


Figure 255. Visual comparison of excavated profile and GPR signal profile of T-111

Test Excavation 111A

T-111A measured 0.6 m by 6 m and was oriented northwest to southeast and was located within the side walk of north of Nimitz Highway, 21 m southeast of Nimitz Highway and Fort Street Mall intersection. The GPR grid measured 2 m by 8 m with 25 cm spacing between Y-transects and 1 m transects between X-transects. Utilities located near the excavation include a telecommunication line 2 m west and an electric line 3 m west. Two utility pipes were encountered 0.2 mbs on the northwest end and a utility jacket was encountered 0.29 mbs along the entire length of the excavation.

A review of amplitude slice maps indicated no linear features although a utility jacket was encountered. Reflectivity was relatively uniform throughout the grid and decreased with depth. A transition from higher reflectivity to lower reflectivity was observed at approximately 0.5 mbs (Figure 256).

GPR depth profiles for T-111A identified horizontal banding, commonly associated with stratigraphic layering, throughout the survey area (Figure 257). This banding corresponded to variations of density and chemical composition within fill deposits. The profile also indicated a change in reflectivity which occurred around 0.1 mbs. Several anomalies were observed in the profile and two corresponded to the utility jacket and pipes that were encountered during excavation. The maximum depth of clean signal return was approximately 0.75 mbs.

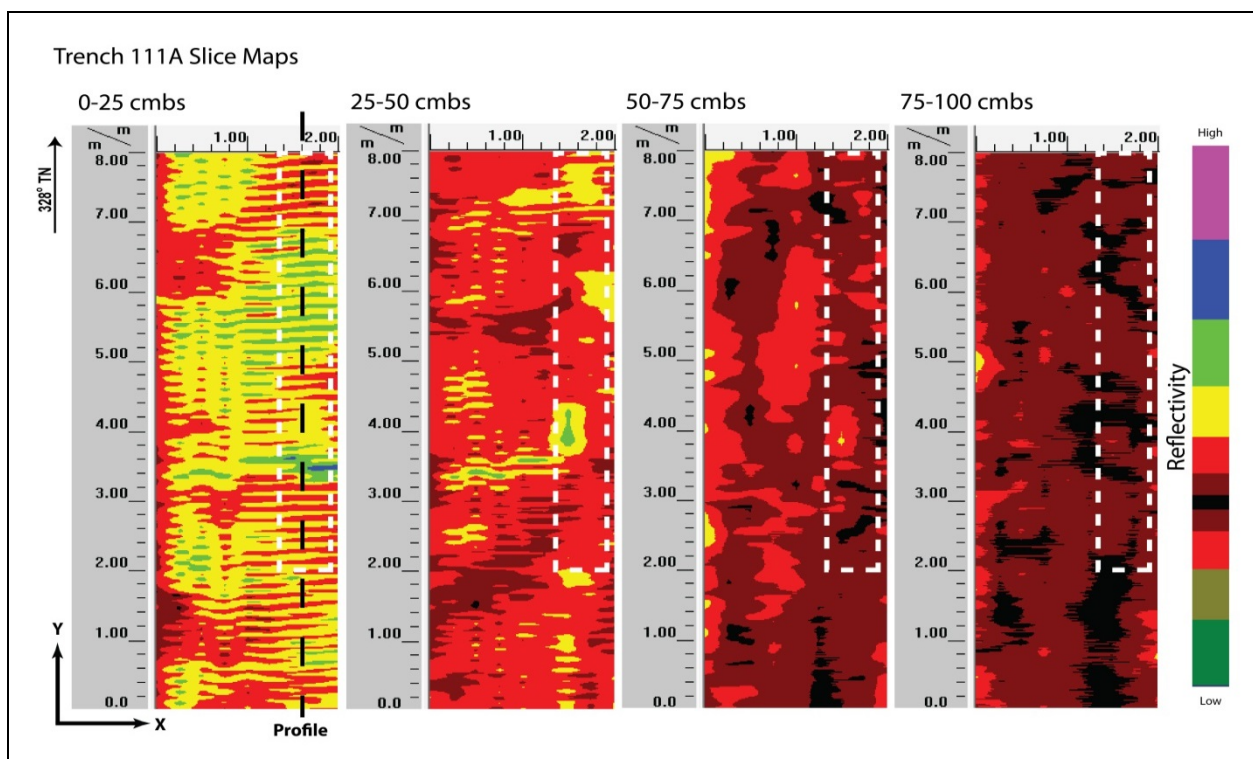


Figure 256. Slice maps of T-111A at 25 cm depth intervals

A visual comparison of the excavated profile and the GPR signal profile showed a strong correlation in stratigraphic transitions (Figure 257). Strata Ia and Ib were clearly observed and occurred at the ground-truthed depths. Strata included a layer of concrete on top of base course. A utility jacket and two pipes were found 0.29 and 0.2 mbs, respectively. These utilities correspond to hyperbola anomalies observed in the GPR signal profile. No other discrete objects or stratigraphic transitions were observed in the GPR results or subsequent excavation.

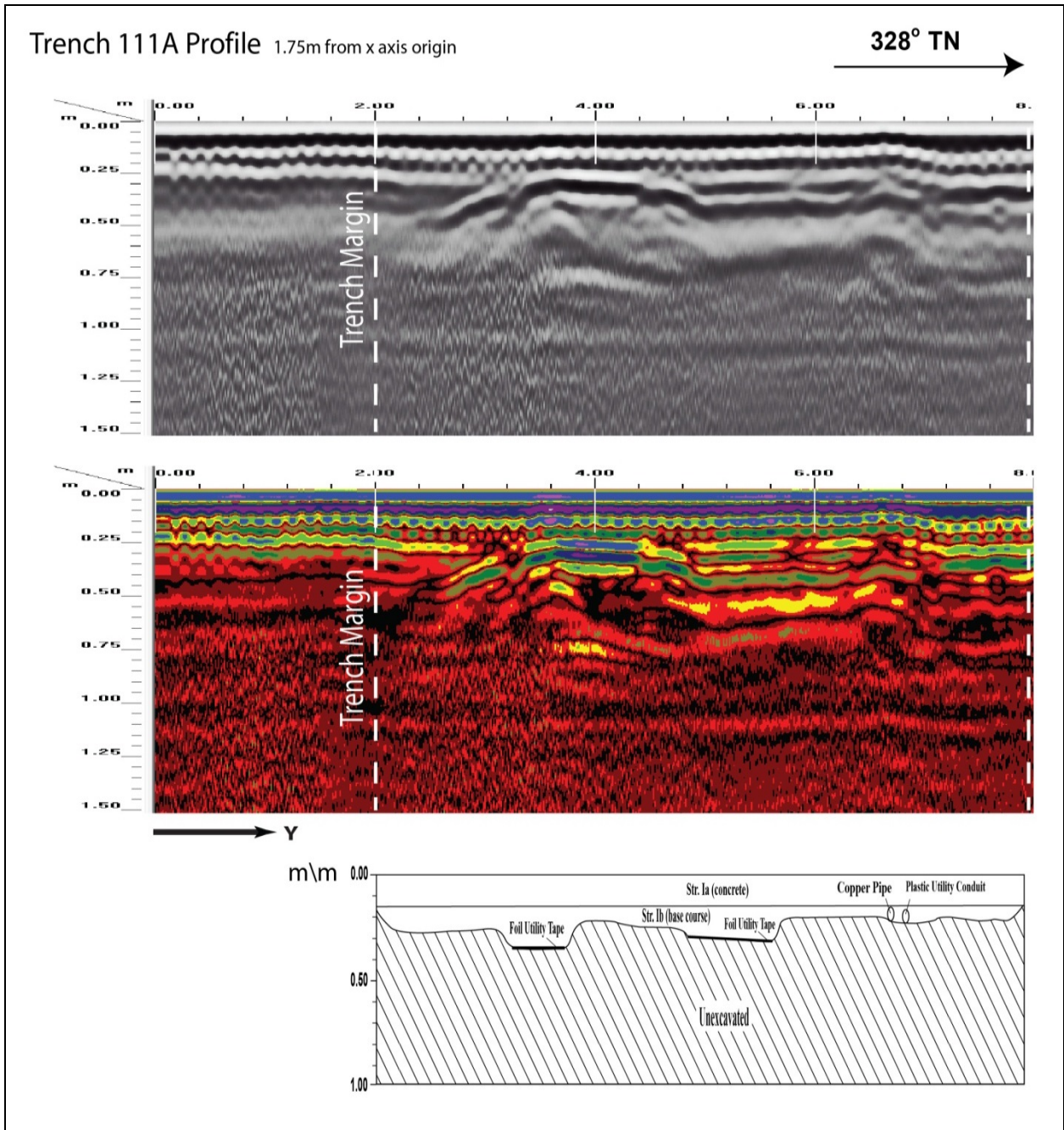


Figure 257. Visual comparison of excavated profile and GPR signal profile of T-111A

Test Excavation 112

T-112 measured 0.6 m by 6 m and was oriented northwest to southeast and was located within the road cut of Nimitz Highway in the southbound lane, 50 m southeast of South Nimitz Highway and Fort Street Mall intersection. The GPR grid measured 3 m by 10 m with 25 cm spacing between Y-transects and 1 m spacing between X-transects. Utilities located near the excavation include fuel line 2.9 m northeast, electrical line 7.4 m east, and a sewer line 9.6 m east. A utility line was encountered 0.7 mbs in the southeast end of the excavation.

A review of amplitude slice maps indicated a linear features which could correspond to the utility encountered during excavation. Reflectivity was relatively uniform throughout the grid and decreased with depth. A transition from higher reflectivity to lower reflectivity was observed at approximately 0.75 mbs (Figure 258).

GPR depth profiles for T-112 identified horizontal banding, commonly associated with stratigraphic layering, throughout the survey area (Figure 259). This banding corresponded to variations of density and chemical composition within fill deposits. The profile also indicated a change in reflectivity which occurred around 0.15 mbs and again around 0.35 mbs. Several anomalies were observed in the profile and one corresponded to the utility encountered during excavation and the others were not within the excavation boundaries. The maximum depth of clean signal return was approximately 1.15 mbs.

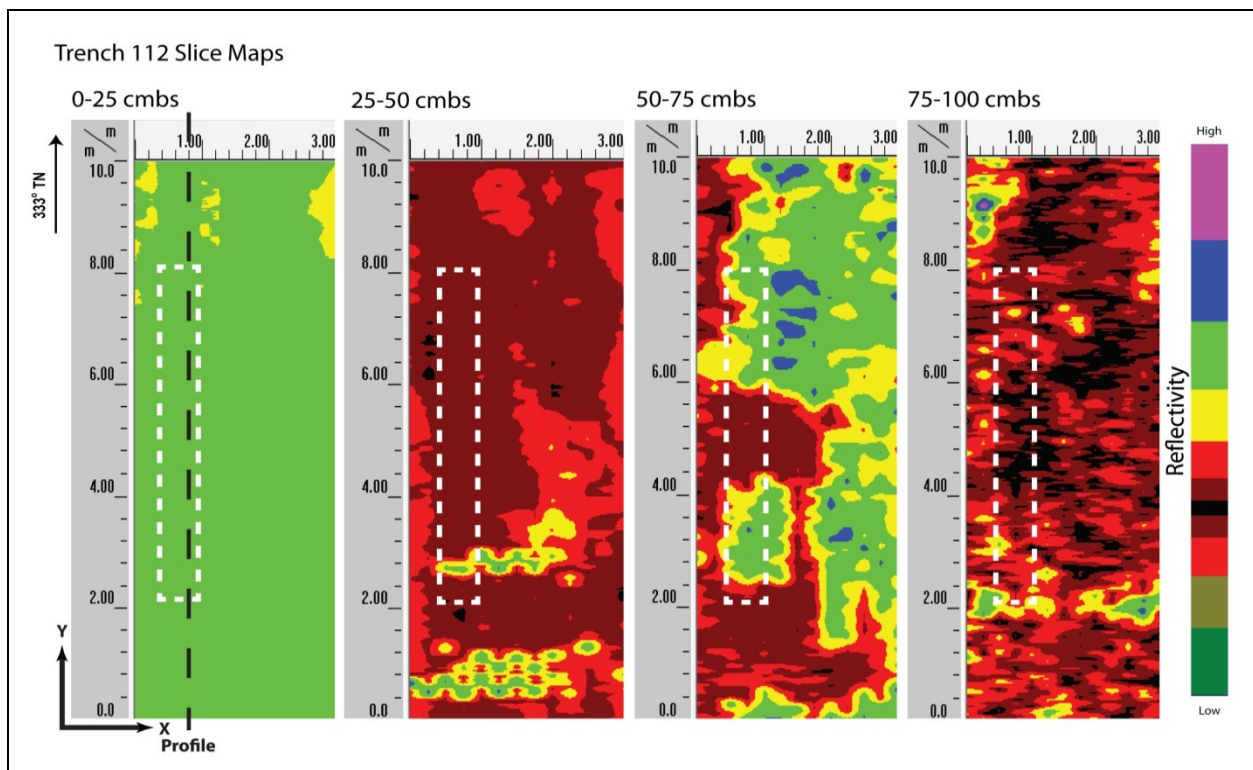


Figure 258. Slice maps of T-112 at 25 cm depth intervals

A visual comparison of the excavated profile and the GPR signal profile showed a strong correlation in stratigraphic transitions (Figure 259). Strata Ia and Ib were clearly observed and occurred at the ground-truthed depths. Textural changes in the form of multiple small hyperbolas were apparent in Stratum Ib which was very cobbly sandy silt fill. A utility pipe was found 0.7 mbs. This pipe corresponded to a hyperbola anomaly observed in the GPR signal profile. All other sediment transitions were below the maximum clean signal return depth. No other discrete objects were observed in the GPR results or subsequent excavation.

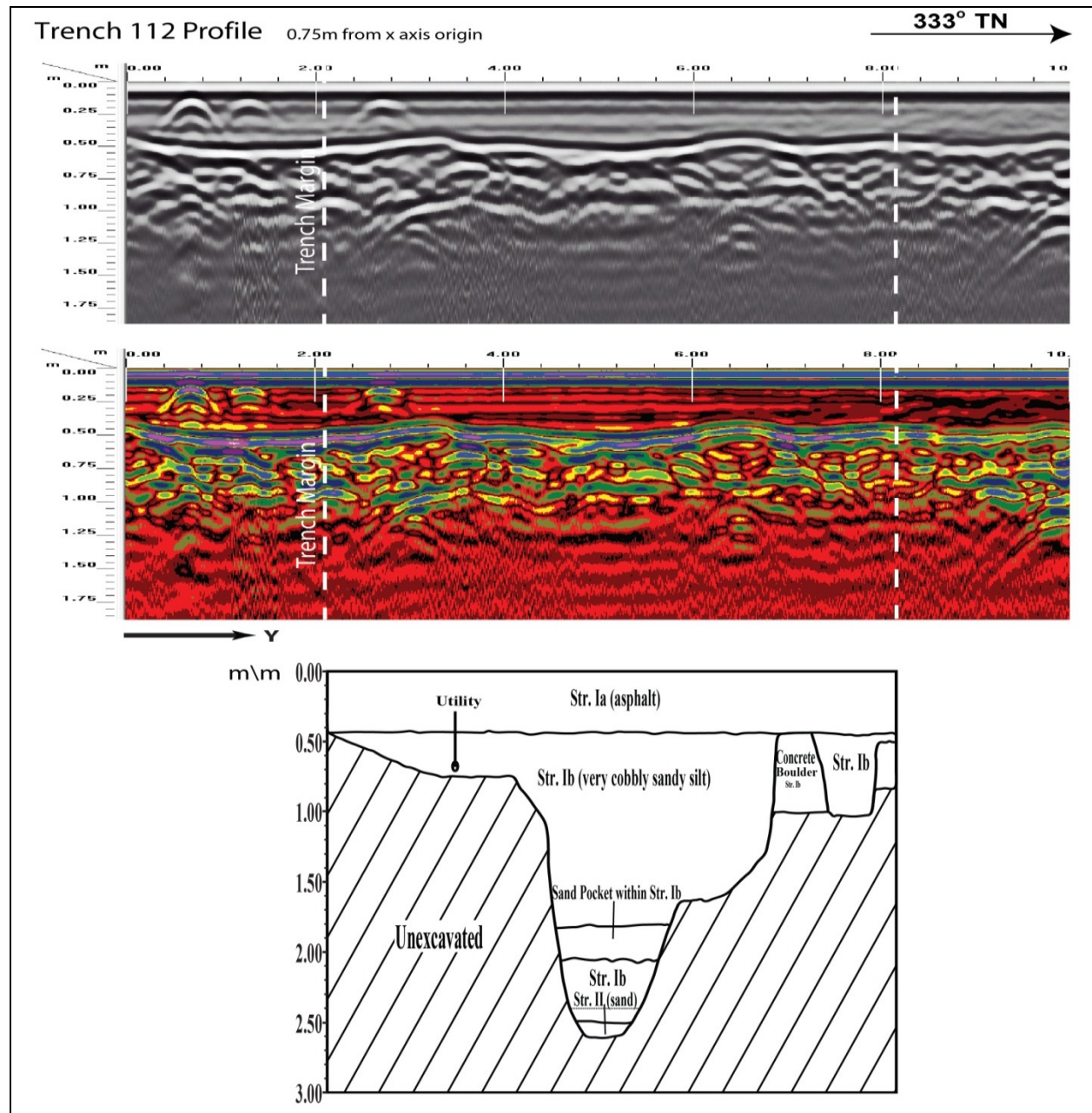


Figure 259. Visual comparison of excavated profile and GPR signal profile of T-112

Test Excavation 113

T-113 measured 0.7 m by 7 m and was oriented northwest to southeast and was located within the road cut of Nimitz Highway in the southbound lane, 15 m northeast of Nimitz Highway and Bishop Street intersection. The GPR grid measured 2.5 m by 10 m with 25 cm spacing between Y-transects and 1 m spacing between X-transects. Utilities located near the excavation include fuel line 2.5 m northeast and an electrical line 4.8 m northeast. No utilities transected the GPR grid or excavation location.

A review of amplitude slice maps indicated no linear features which might have indicated the presence of utilities. Reflectivity was relatively uniform throughout the grid and decreased with depth. A transition from higher reflectivity to lower reflectivity was observed at approximately 0.25 mbs (Figure 260).

GPR depth profiles for T-113 identified horizontal banding, commonly associated with stratigraphic layering, throughout the survey area (Figure 261). This banding corresponded to variations of density and chemical composition within fill deposits. The profile also indicated a change in reflectivity which occurred around 0.1 mbs and again around 0.5 mbs. No utilities were observed in the profile. The maximum depth of clean signal return was approximately 1.0 mbs.

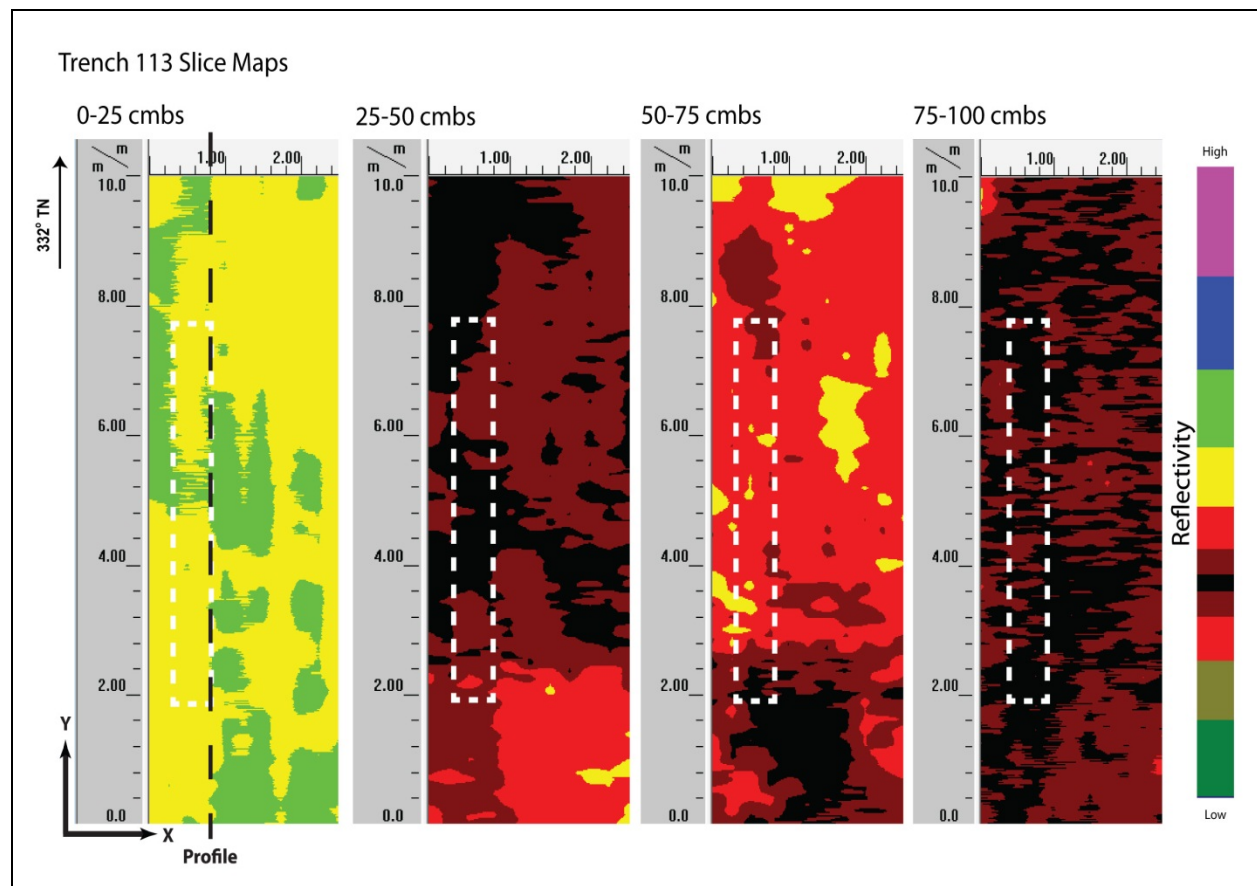


Figure 260. Slice maps of T-113 at 25 cm depth intervals

A visual comparison of the excavated profile and the GPR signal profile showed a strong correlation in stratigraphic transitions (Figure 261). Strata Ia and Ib were clearly observed and occurred at the ground-truthed depths. Strata included a thick layer of asphalt on top of sandy loam fill. All other sediment transitions were below the maximum clean signal return depth. No discrete objects were observed in the GPR results or subsequent excavation.

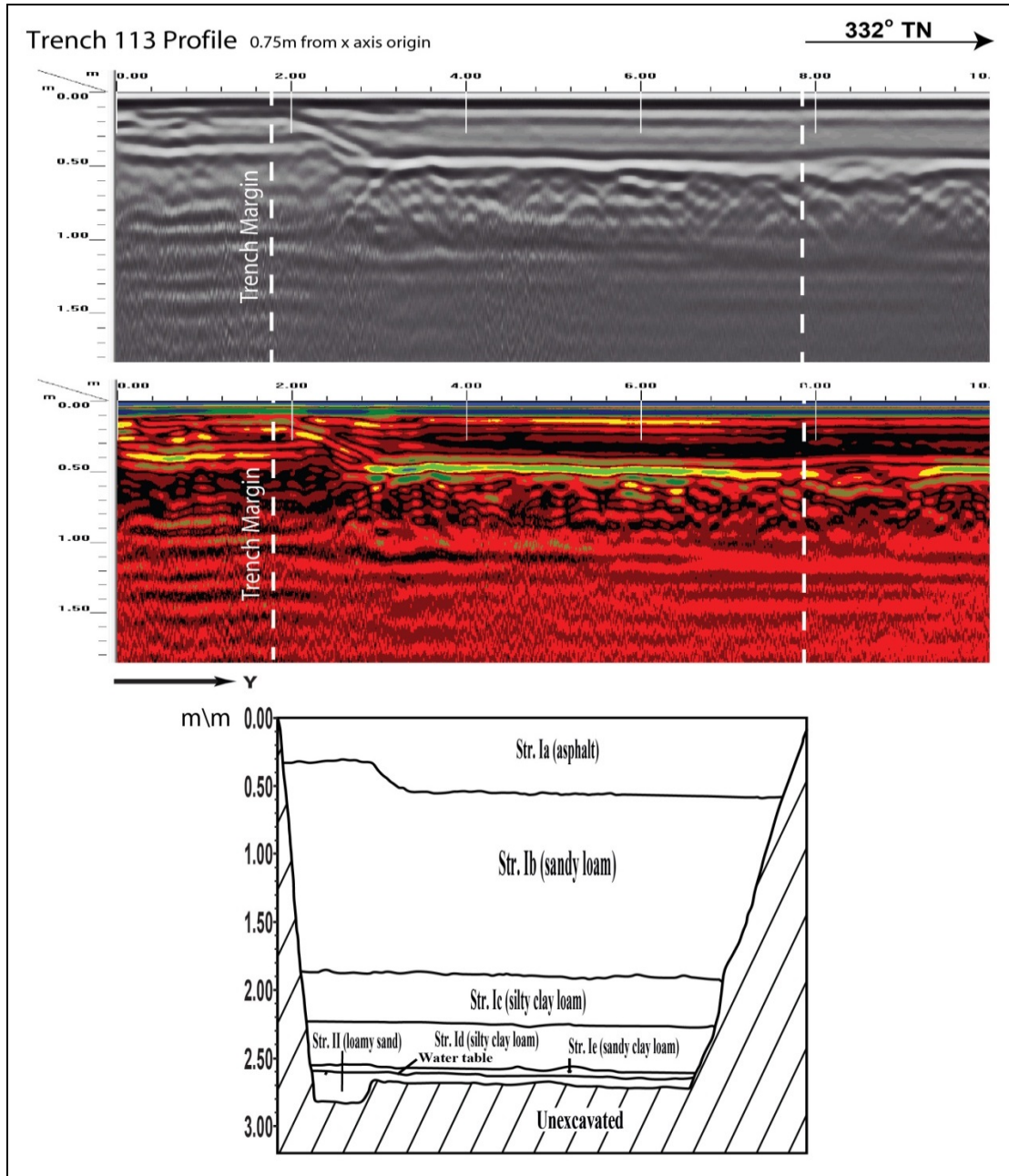


Figure 261. Visual comparison of excavated profile and GPR signal profile of T-113

Test Excavation 114

T-114 measured 0.9 m by 3 m and was oriented north to south and was located 15 m northeast of Nimitz Highway within the courtyard of The Pacific Guardian Center between Bishop Street and Alakea Street. The GPR grid measured 2 m by 9 m with 25 cm spacing between Y-transects and 1 m spacing between X-transects. Utilities located near the excavation include sewer line 4.8 m south and 8.3 m southwest. A concrete jacket was encountered 0.48 mbs in the southeastern end and three utility pipes were encountered in the northwest corner of the excavation at 0.28, 0.47 and 0.82 mbs.

A review of amplitude slice maps indicated a linear feature that corresponded to a drain but none of the utilities or the concrete jacket were observed in the slice maps. Reflectivity was relatively uniform throughout the grid and decreased with depth except for the drain. A transition from higher reflectivity to lower reflectivity was observed at approximately 0.5 mbs (Figure 262).

GPR depth profiles for T-114 identified horizontal banding, commonly associated with stratigraphic layering, throughout the survey area (Figure 263). This banding corresponded to variations of density and chemical composition within fill deposits. The profile also indicated a change in reflectivity which occurred around 0.3 mbs. An anomaly was observed in the profile that corresponded to the drain but the utilities and concrete jacket were not observed in the GPR profile. The maximum depth of clean signal return was approximately 1.0 mbs.

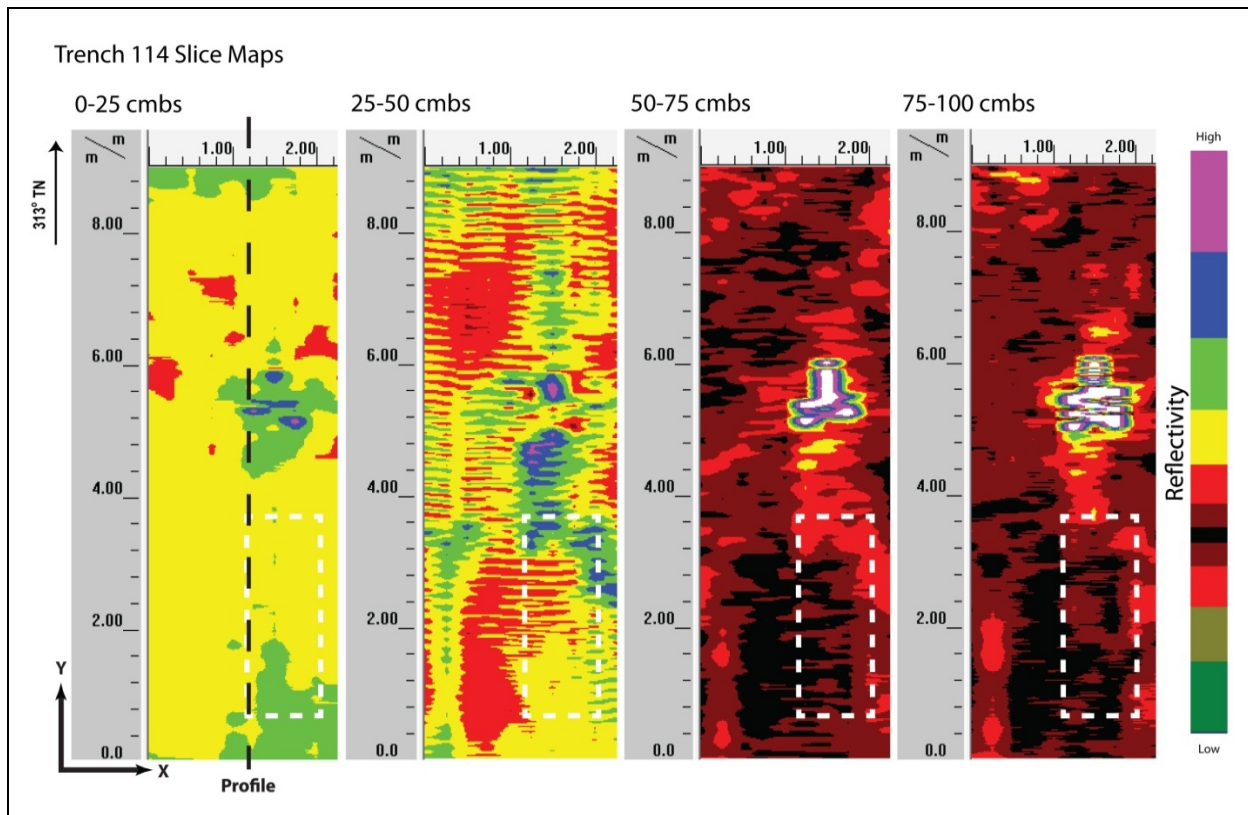


Figure 262. Slice maps of T-114 at 25 cm depth intervals

A visual comparison of the excavated profile and the GPR signal profile showed a strong correlation in stratigraphic transitions (Figure 263). Strata Ia to Ic were clearly observed and occurred at the ground-truthed depths. Strata included a layer of tiled concrete on top of a very thin layer of loamy sand fill followed by extremely gravelly silt loam fill. Three pipes and a concrete jacket were found 0.28, 0.47, 0.82, and 0.48 mbs, respectively. None of these utility pipes or the concrete jacket showed up on the profile or slice maps. This may be due to the fact that the pipes were empty and that the concrete jacket did not contain reinforced steel (rebar). The pipes and the jacket could have also had a similar density to their surrounding stratum. All other sediment transitions were below the maximum clean signal return depth. No other discrete objects were observed in the GPR results or subsequent excavation.

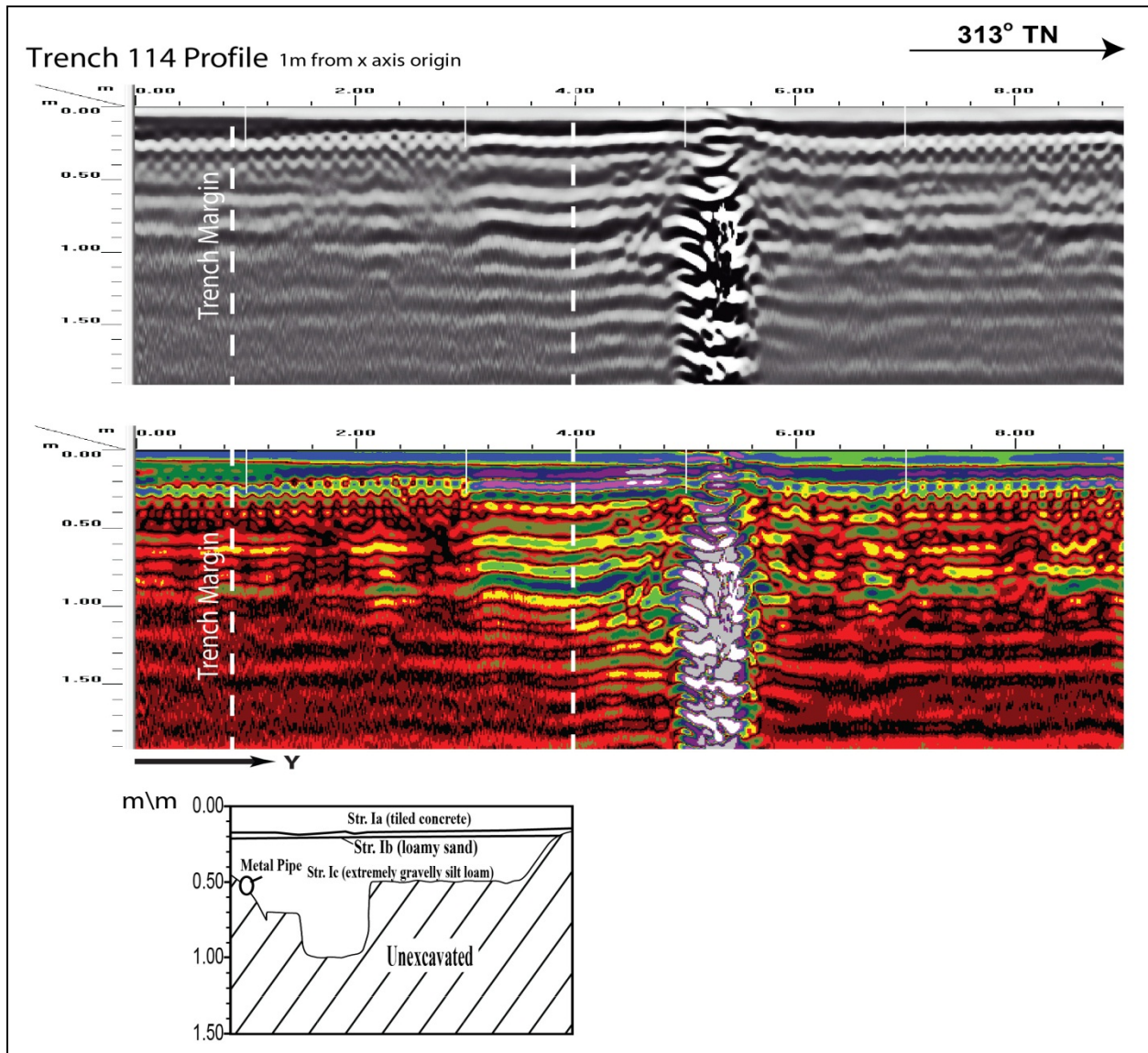


Figure 263. Visual comparison of excavated profile and GPR signal profile of T-114

Test Excavation 115

T-115 measured 0.7 m by 7 m and was oriented northwest to southeast and was located within the road cut of Nimitz Highway in the southbound lane, 45 m northwest of Nimitz Highway and Alakea Street intersection. The GPR grid profile measured 2 m by 10 m with 25 cm spacing between Y-transects and 1 m spacing between X-transects. Utilities located near the excavation include sewer line 1.2 m southwest, waterline 1.8 m northeast, and an electrical line 2.8 m northeast. No utilities transected the GPR grid or excavation location.

A review of amplitude slice maps indicated no linear features which might have indicated the presence of utilities. Reflectivity was relatively uniform throughout the grid and decreased with depth. A transition from higher reflectivity to lower reflectivity was observed at approximately 0.25 mbs (Figure 264).

GPR depth profiles for T-115 identified horizontal banding, commonly associated with stratigraphic layering, throughout the survey area (Figure 265). This banding corresponded to variations of density and chemical composition within fill deposits. The profile also indicated a change in reflectivity which occurred around 0.15 mbs and again around 0.5 mbs. No utilities were observed in the profile. The maximum depth of clean signal return was approximately 1.15 mbs.

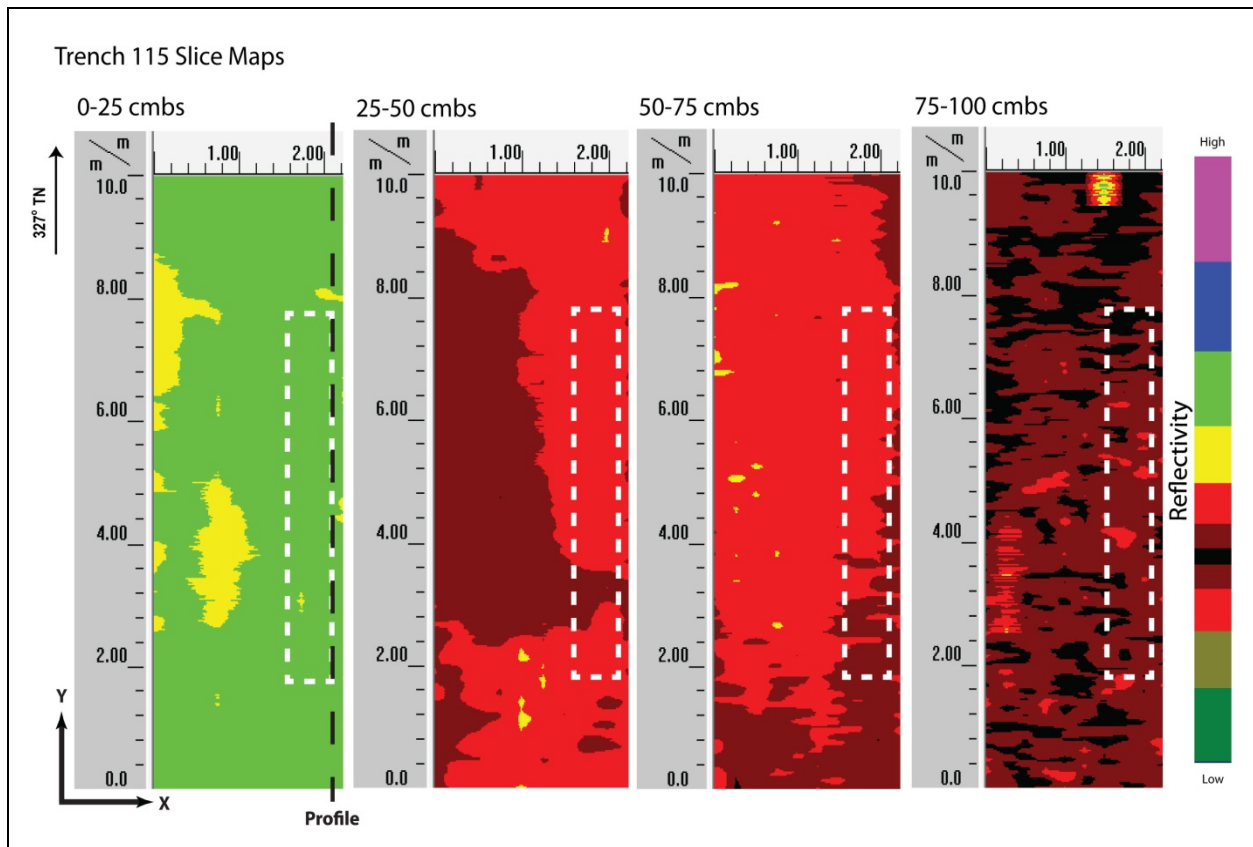


Figure 264. Slice maps of T-115 at 25 cm depth intervals

A visual comparison of the excavated profile and the GPR signal profile showed a strong correlation in stratigraphic transitions (Figure 265). Strata Ia to Ic were clearly observed and occurred at the ground-truthed depths. Textural changes in the form of multiple small hyperbolas were apparent in Stratum Ic which was gravelly sandy silt fill. All other sediment transitions were below the maximum clean signal return depth. No discrete objects were observed in the GPR results or subsequent excavation.

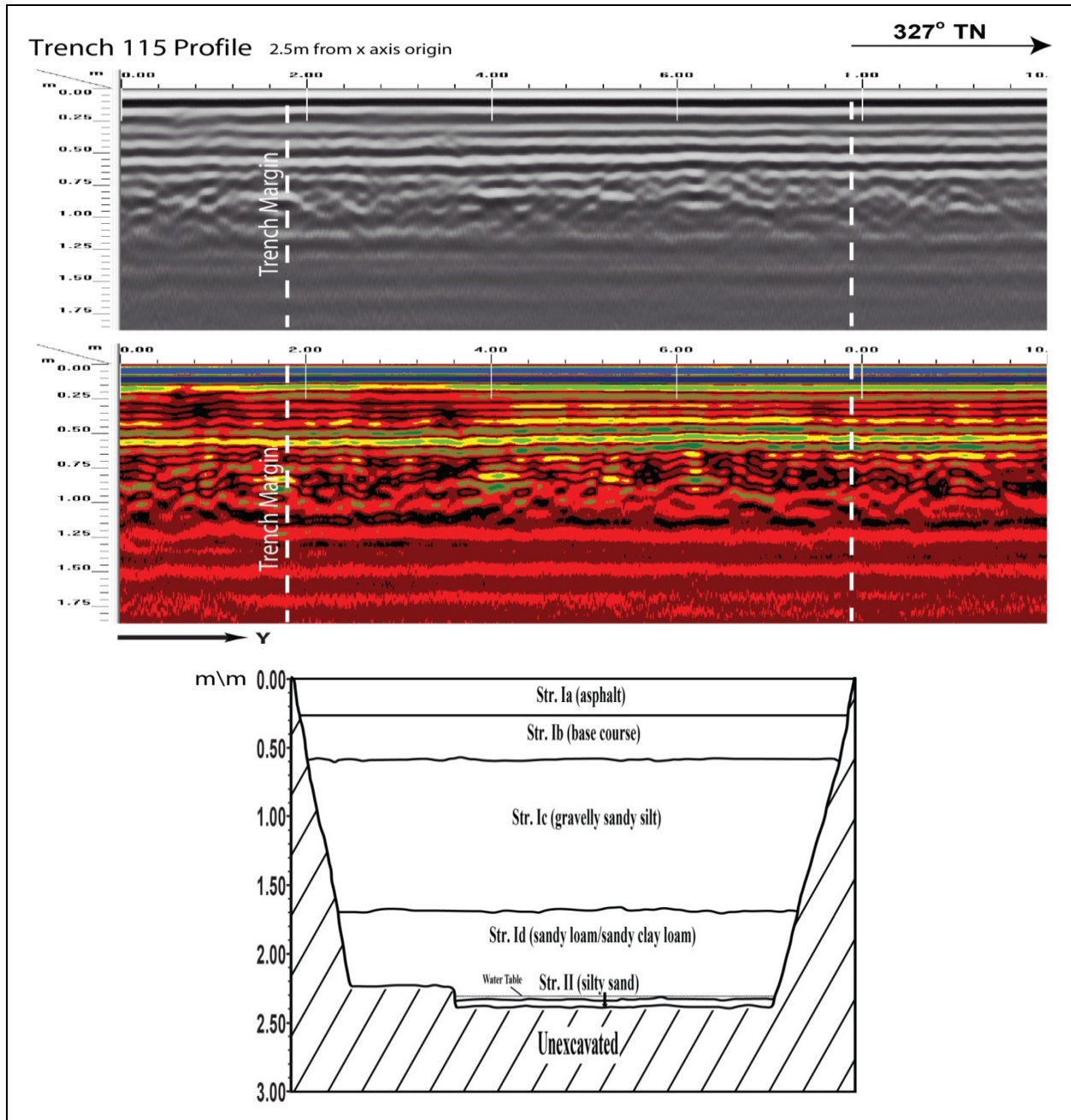


Figure 265. Visual comparison of excavated profile and GPR signal profile of T-115